

# SCIENTIFIC AMERICAN

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Vol. XCIX.—No. 21.  
ESTABLISHED 1845.

NEW YORK, NOVEMBER 21, 1908.

[10 CENTS A COPY  
\$2.00 A YEAR.]



Henry Farman making the first cross-country flight that has ever been accomplished with an aeroplane. The 17 miles between the military camp at Chalons and the city of Rheims, France, were covered in about 20 minutes.

A NEW ERA IN AERIAL NAVIGATION.—[See pages 350 and 357.]

## SCIENTIFIC AMERICAN

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MUNN &amp; CO. - - - Editors and Proprietors

Published Weekly at  
No. 361 Broadway, New YorkCHARLES ALLEN MUNN, President  
361 Broadway, New York  
FREDERICK CONVERSE BEACH, Sec'y and Treas.  
361 Broadway, New York

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One copy, one year, for the United States or Mexico ..... \$3.00  
One copy, one year, for Canada ..... 3.75  
One copy, one year, to any foreign country, postage prepaid, 18s. 6d. 4.80

## THE SCIENTIFIC AMERICAN PUBLICATIONS.

Scientific American (established 1845) ..... \$3.00 a year  
Scientific American Supplement (established 1878) ..... 5.00 "  
American Homes and Gardens ..... 3.00 "  
Scientific American Export Edition (established 1878) ..... 3.00 "

The combined subscription rates and rates to foreign countries, including Canada, will be furnished upon application.

Remit by postal or express money order, or by bank draft or check.  
MUNN & CO., 361 Broadway, New York.

NEW YORK, SATURDAY, NOVEMBER 21, 1908.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are sharp, the articles short, and the facts authentic, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

## A MONUMENTAL BLUNDER.

And so it seems that our worst fears regarding the \$24,000,000 Blackwell's Island Bridge are verified; for we are now assured that this, the greatest engineering work of its kind in the world, would collapse, if it were subjected to the loads which it was designed to carry. A little over a year ago, that other great cantilever structure, the Quebec Bridge across the St. Lawrence, crumpled up under its own weight and fell into the river below. Naturally, public attention was at once directed to the Blackwell's Island Bridge; and since it was designed on the same general principles which had been found to be faulty, in some particulars, as developed in the Quebec Bridge, the public demanded that an investigation to determine the actual strength of the structure be made by independent engineers. To this the Bridge Department consented; and Prof. Burr, of Columbia University, and Messrs. Boller & Hodge, bridge engineers, of this city, were asked to make such an investigation. Their reports, which have recently been made public, show that if the bridge were opened and subjected to the loads which it was designed to carry, the strains, in some of the members, would enormously exceed those for which the bridge was designed, the excess in the case of one member rising to 47 per cent above the safety point!

Very wisely, when the construction of the bridge was determined upon, the Bridge Department decided to make it strong enough to carry the greatest possible congested loading that could be put upon it; and it was found that, when so loaded, it would be carrying 16,000 pounds of moving weight upon every lineal foot of its length. Subsequently to the completion of the plans, it was decided that to meet the demands of the future it would be desirable to increase the strength of the bridge to accommodate four elevated tracks upon its upper deck, two extra tracks being added to the two already provided for. This, of course, involved a very large increase in the live loads, to say nothing of an increase in the strength and weight of the bridge itself, to carry this extra load.

Prudence would have suggested that at this point a complete recalculation of the bridge be made, and a new strain sheet drawn up showing the exact stresses which would occur under the heavier loading, throughout the whole bridge. As far as we can learn no such sheet was prepared, the first strain sheet being accepted as correct, and a *pro rata* increase being made in the section of the various members.

When Messrs. Boller & Hodge began their investigations, they wisely determined that the first thing to do was to ascertain what were the actual conditions of stress in the structure as built. Accordingly, they secured the shipping bills showing the weight of every piece of steel that had been built into the bridge, checking these weights by careful measurement of the various members, and from the weights as so received by them and checked, and upon the specification loading of 16,000 pounds to the lineal foot, they drew up a strain sheet, which the Editor recently had an opportunity to inspect, showing the actual conditions in the structure as it stands to-day.

The results are simply appalling. They mark this bridge as the most monumental case of faulty design in the whole history of the art of designing long-span bridges. Furthermore, our readers should understand that, when the maximum stress to which the metal in the bridge could be safely subjected was determined upon, no allowances were made for secondary stresses in the various members (due to tendency to distortion in the members themselves), or for snow load. The omission of snow load is simply amazing; for it

means that in the event of a blizzard like that of 1888, in which the vast floors of the bridge and all the huge members might be loaded deep with a heavy burden of snow, the stresses resulting in the structure from this load would not be represented by any corresponding increase of material in the members to carry the additional burden thus imposed. Nor is it an answer to this criticism to say that the bridge might not be congested with traffic at such a time; for it is certain that a heavy blizzard might in itself be the cause of a stalling of trains and cars, and a blockade of vehicular traffic.

That our estimate of the magnitude of the blunder committed in this bridge is not overdrawn is shown by the following facts selected from the two reports: Prof. Burr says: "The result of these computations shows . . . that some of the bottom chord panels of the island span would carry about 25 per cent more than is permitted by the contract specification. . . . There would be also some similar overstresses in riveted tension members in the same parts of the bridge, rising above 33 per cent in a single instance." Prof. Burr exhibits here as elsewhere in his report a tender commiseration for the blunders committed; for he fails to mention that in this "single instance" the overstress rises, as shown by the strain sheet of Boller & Hodge, to no less than 47 per cent above what is allowed by considerations of safety.

When Messrs. Boller & Hodge had proved that the bridge, if subjected to the loading for which it had been calculated, or rather miscalculated, by the Bridge Department, must inevitably collapse into the East River, they set about the calculation of a strain sheet showing what loads the bridge actually could carry, without exceeding the safe limits of stress in the individual members as called for by the specification and by all good engineering practice. And what did they find? *That instead of being able to carry a congested load of 16,000 pounds per lineal foot, the bridge as it stands to-day can carry a load only of 6,000 pounds per lineal foot; and that even this live load can be safely allowed on the bridge, only if the traffic is carefully regulated by the police; that is to say, if a certain distance be maintained between the trolley cars. This last restriction, being interpreted, means that, if, through carelessness or connivance, the spacing between cars be not maintained, and, as in the case of a sudden accident or panic, the cars become bunched together, the safety of the bridge, even under a live load nearly two-thirds less than that for which it was designed, will be imperilled!*

But how is the loading to be reduced to this extent? Boller & Hodge in their report show that it can be done only by removing from the bridge the whole of the four elevated tracks which it was designed, or supposed to be designed, to carry. In other words, this \$24,000,000 structure, whose greatest usefulness ultimately would have consisted in its serving as a link between the heavy electric train service, whether subway or surface, of Greater New York, is found to be totally unfit for such a purpose, and must be limited to the service of trolleys, trucks, and pedestrians. No elevated trains on a bridge, for whose approaches nearly half a mile of elevated structure has already been built!

It is beside the mark for apologists, in the endeavor to lighten the gravity of the situation, to suggest that 16,000 pounds per foot is a loading which may never occur. That loading was adopted as a measure of safety and as a means of covering the inevitable growth of traffic in the future. As a measure of precaution, it does not lose its importance in our eyes, because someone has committed a costly blunder in the Bridge Department.

## A NEW ERA IN AEROPLANE TRANSPORT.

After his failure to make satisfactory flights in this country last summer, and after losing to Wilbur Wright the prize of the French Aero Club for the longest flight up to October 1, Henry Farman has at last shown himself to be, after all, one of the world's most daring aviators, while at the same time he has opened a new era in aeroplane flight, an era in which the flying machine will be put to practical use in the transport of individuals from place to place.

After a 25-mile flight above the camp at Chalons, France, on October 28, and a mile flight with a passenger the same day, Farman made some changes in his machine to improve its stability. Then, on the 30th, he again soared aloft above the camp; but this time, after describing one or two circles, he flew straightaway across country at a height of 100 feet, and did not alight until some 20 minutes later, when he reached the outskirts of Rheims, after traversing a distance of 17 miles. Our frontispiece shows him passing over one of the intervening villages, before the astonished gaze of several spectators. It was his intention to return in the same manner; but owing to the late hour and the making of some small repairs, he took the aeroplane apart and returned it to Chalons by road.

Not to be outdone by his compatriot, M. Louis Bleriot the next day made a 9-mile flight with his aeroplane across country from Toury to Artenay; and, after making a slight repair, returned to the starting point, making one stop en route. A photograph of the monoplane made during this flight appears on page 357.

These two remarkable performances have put France in the lead as far as practical cross-country flight is concerned. They have shown the possibility of winning the \$50,000 prize of the London Daily Mail for a flight in stages from London to Manchester, and also the prizes totaling \$10,000 for a flight across the English Channel. Furthermore, they have assured the holding of a cross-country aeroplane race next summer in France. A prize of \$20,000 has been put up by the Aero Club of France, and it is proposed to run the race from Paris to Bordeaux in five stages.

Had it not been for his unfortunate accident, it is probable that Orville Wright would have made the first cross-country aeroplane flight at least a month before Farman, as the government requirements called for a ten-mile flight of this kind in making the speed test. As no such performance was required by the syndicate which has bought the Wright patents in France, Wilbur Wright has contented himself with making lengthy flights above a level field, in windy as well as in calm weather, and also with teaching several men the operation of his machine. He does not favor such spectacular performances as that of Farman, which, he claims, could not have been made save under ideal weather conditions and with the running of an extreme risk of accident.

## WILBUR WRIGHT'S RECORD FOR HEIGHT.

After lengthening the rail from which his aeroplane starts some 35 feet, in order to enable him to attain the necessary speed by means of his propellers alone, Mr. Wilbur Wright competed successfully on the 13th instant for the prize for height offered by the Aero Club of France. The rules forbid the use of a dropping weight for starting the aeroplane, so Mr. Wright was obliged to dispense with his usual starting apparatus. His machine, however, started readily under its own power. At the end of a 5-minute flight, he cleared the line of small balloons placed at a height of 30 meters (98.4 feet) by 49 feet, making a total height of 147.4 feet. In a second flight of 11 minutes' duration, Mr. Wright is said to have risen to a height of 196 feet above ground. These are the first official records for height that the American aviator has made.

## THE HANDY MAN'S WORKSHOP.

Among the features which have contributed to the success of the SCIENTIFIC AMERICAN have been articles written for the benefit of the amateur mechanic—articles which told in a simple way how motors, dynamos, batteries, barometers, and a hundred other machines and instruments can be constructed at home without elaborate tools. These articles have been the means of giving to thousands of young men of technical inclinations an electrical and mechanical training, which because of its eminently practical nature, admirably fitted them for the more serious work of the machine shop and the electrical laboratory.

In order to broaden this department of the journal, and to render it even more useful than it has been in the past, we have decided to publish about twice a month shorter accounts, which will tersely yet clearly describe simple devices which can be made by anyone who is reasonably skillful in the use of simple tools, and which will be devoted to the description not only of experimental apparatus, but of utensils and implements for everyday use. The department bears the general title, "The Handy Man's Workshop," and we intend to include under the heading all that it implies. The articles will explain the construction of simple physical apparatus, as in the past, but above all they will be devoted to the making of contrivances that a "handy man" can use about the house. In next week's issue we intend to publish brief articles on the making of simple Christmas toys at home—toys that will be far more intimate and personal in their appeal than factory-made products. That issue of the SCIENTIFIC AMERICAN will be a very practical Christmas number.

The reception thus far accorded to the innovation justifies us in assuming that "The Handy Man's Workshop" will prove one of the most popular departments in the SCIENTIFIC AMERICAN. Because it is still new, we shall be glad to receive suggestions from our readers for its improvement—if improvement it needs.

Judiciously used, the automobile may offer a remedy for nervous and mental affections. Dr. A. Mounteyrat, a French physician, ventures the opinion that motoring is a cure for anemia and sleeplessness. He conducted some experiments during several tours of eight days each and states that he found a decided increase in the number of red corpuscles. The average increase figures out at 26 per cent. The effect of a week's touring is much the same as that of residence on high altitudes.



# ENGINEERING.

Negotiations have recently been completed for the construction at Southampton of a large drydock capable of accommodating the new steamers "Olympic" and "Titanic" of the White Star Line. The new dock is to have a depth of 40 feet of water at low tide, so that it can accommodate these vessels at any hour at which they may arrive.

It is reported that the engineers who will design the new Quebec Bridge are considering the question of placing the new structure 10 feet higher above the St. Lawrence River than the bridge that fell. The clearance of the fallen structure was 150 feet above high water. The change is designed to accommodate ships that make Montreal a port of call.

The Navy Department will shortly issue invitations for bids for the construction of a long-distance wireless station in Washington, which is to be of exceptional power and is designed to enable the Department to hold communication with vessels over 2,000 miles distant. Proposals will also be asked for a wireless equipment for ships, to have a radius of not less than 1,000 miles.

The announcement that the Japanese are about to open the railroad which they have built in Formosa is the latest evidence of the good work which they are doing in the island, which was acquired in 1895, at the close of the war with China. At the time of the transfer 62 miles of the road were completed. It now covers a total of 334 miles, and Japan has built the additional 272 miles at nearly \$2,000,000 less than the estimates.

The War Department is engaged in experiments to determine what can be done in the way of compressing coffee and sugar into tablet forms under conditions which will preserve them for a lengthy period, with a view to including the product in the new haversack ration which has been adopted for the army. This ration includes hard bread, bacon put up in tins, and salt and pepper carried in stout separate envelopes.

The recent award by the Pennsylvania Railroad Company of a \$5,000,000 contract to the Westinghouse Company for the electrification of the New York terminals and tunnel connections, is one of the most encouraging signs of the present revival of business activity. During the past two years this railroad has been conducting an exhaustive series of tests, both of electric locomotives and of the different methods of generation and transmission, which have terminated in the placing of this important order.

It seems likely that the first monorail passenger line to be installed on any scale in the United States will be built within the limits of New York city on the route of the old horse-car line from the New Haven Railroad tracks to City Island. The cars will be carried on two two-wheeled trucks, each pair of wheels running in tandem on a single rail, spiked to ties laid on the ground. Stability will be obtained by two overhead trucks, carried on flexible arms, each truck running on L-shaped overhead rails carried on standards. The guide rails will act as conductors, the current being taken through the flexible arms to the motors.

The report of the commissioners appointed by President Roosevelt to consider the question of mine explosions, attaches great importance to the employment for the handling of explosives only of men noted for their great prudence. To prevent the ignition of coal dust, they advise thorough wetting of the mine for a distance of 60 feet from the shot that is to be fired. They recommend that close attention should be given to the question of leaving such an amount of support to the roof of a mine that it cannot fall in the event of an explosion, and thereby imprison the workmen. Equally important is the suggestion that employees be removed from the mine when a shot is to be fired. It is also urged that there should be strong co-operation between the government and the operators of mines in the maintenance of strict discipline, and that there should be careful periodic inspection by a corps of competent men.

It was inevitable that the proposals submitted to the Public Service Commission for the construction of a freight subway beneath the streets of New York city would result in a storm of protest from the trucking interests; and hence the opposition of the truckmen at the public hearing before the commission excites no surprise. From time immemorial the attempted introduction of improved means of transit has been fought bitterly by the older systems, whose inconvenience and expense they were designed to avoid. The guiding principle, however, in all such conflicts of private and public interests should be that of the greatest good of the greatest number. The obstruction of the city's streets and sidewalks by the present method of freight distribution has become intolerable; and it is certain that if the proposed subway can be shown to be commercially feasible it will prove to be one of the greatest improvements ever made in this city.

# ELECTRICITY.

The Navy Department is considering the building of a long-distance wireless telegraph station near Washington which will have a sending radius of 3,000 miles. This station will supersede the present stations along the Atlantic coast. The Department also expects to call for bids on a pair of high-power ship equipments with sending radius of 1,000 miles each.

A movement is on foot in England to reduce cable charges to America and cut the rate between England and the Continent to two cents a word. The idea is to have the various governments obtain control of the cables, and thus permit their use at the lowest possible figures. No doubt this movement will result in considerable complication, owing to the international agreements that would be required.

According to a recent consular report, there is a total water power in Switzerland of 1,000,000 horsepower, three-quarters of which may be exploited, though at present only one-quarter of this is utilized. Steps have been taken to protect the use of the streams, with a view to prevent the transmission of current to foreign countries. A resolution was recently passed by the Swiss Congress, placing the utilization of water power entirely under control of the federal government.

Advocates of municipal ownership have received a serious blow in Chicago. The city has been lighting its street lamps, 7,647 of them, at \$81.64 each per year. At the same time, they have been renting lamps at a cost of \$75 per year. According to the report of Bion J. Arnold and the auditor, Arthur Young, the city has been wasting between \$200,000 and \$300,000 per year by endeavoring to manufacture its own electricity instead of buying it from private plants. The municipal plant has cost \$3,639,931, whereas its actual value to-day is but \$2,353,869.

The United States Geological Survey is recommending the use of electric power in mines. The electrical equipment, however, must be installed with great care, so as to guard against danger of fire or shock. The underground voltage should not exceed 650 for direct current, or 500 for alternating current, and lower voltages are preferable. Where a higher voltage is used, it should be transmitted by a completely insulated cable. No live electric wire should be permitted in any part of the mine in which gas is found to the amount of two per cent.

The new pay-as-you-enter cars of the Chicago Railways Company will soon be put into service. These cars are provided with very long vestibules, permitting two passengers to enter and leave abreast. The overhang from the center of the trucks is 14 feet, and a very strong construction is necessary to prevent sagging of the platforms. The interior of the car is provided with cross seats, except for a pair of side seats at each end. Each cross seat is provided with a push button, which operates a buzzer over the motor-man's head. Special precautions have been taken to thoroughly insulate the wiring. The trolley circuit is incased in a metal conduit on the roof of the car.

The increased use of electricity on the Pennsylvania Railroad has led to a study of the dangers of handling live wires, and the methods that must be employed in resuscitating those who have been stunned by an electric shock. A special pair of pliers has been designed, which enables a man to cut a live wire carrying 23,000 volts without danger to himself. To remove the wire from a body when no other means are at hand, a coat is placed under the wire, and lifted by the sleeves, to raise the wire off the body. This was found perfectly safe, even when the garment was damp. Experiments with fire streams showed that there was no danger of the current flowing down the stream of water even from a high-voltage line when the operator held the nozzle at a distance of between three and four feet from the wire. Experiments with chemical extinguishers showed that they were very dangerous where a solid stream was played on the wire.

A new rectifier has recently been brought out which is entirely mechanical in its operation. It consists of a cylinder of insulating material provided with a pair of metallic contact points. Mounted on a ring which surrounds the cylinder are two pairs of contact points and there are in addition four rectifying disks of carbon which with the cylinder are rotated by a motor. By means of a pair of condensers, sparks are made to leap between the points on the rotating cylinder and first one and then the other pair of contact points. The current flows across the gaps between the points and the rectifying disks when the resistance is broken down by the spark, and is conducted to the storage battery intermittently, but always in the same direction. When starting the rectifier, the motor is brought to synchronism by cranking. The rings on which the four points are carried may be revolved about its axis, so that the condenser will discharge at any point of the wave, and thus the voltage of the rectified current may be regulated.

# SCIENCE.

The excavations at Pompeii have led to the discovery of two supulchral monuments, the first belonging to the Edile Vestorius Priscus, which is decorated with frescoes, and the second to a woman named Septimia. The latter has a marble inscribed tablet intact and a semi-circular seat raised around a column surmounted by a sun dial, which is identified as an exact reproduction of the mosaic picture (so-called) of philosophers lately discovered at the same spot.

Artificial silk is very deficient in strength, especially when wet, but strong threads and fabrics which have the gloss of silk and are not affected by water can be made by subjecting cotton to various treatments. The oldest process, mercerizing or stretching the fibers in a bath of caustic alkali, produces an inferior gloss. In the newer methods, the cotton fibers are practically covered with a coating of artificial silk, either by dipping them into solutions of cellulose similar to those from which artificial silk is made, or by treating them with solvents of cellulose and thus forming the silky coating out of the fibers themselves. The limitations of silk produced by these methods are very glossy and very strong and durable, for exposure to moisture weakens only the coating and not the body of the fiber.

The distinguished seismologist Emilio Oddone has expressed the view that a great earthquake may, by agitating the whole mass of the earth, cause another great earthquake in a distant and unstable part of the earth's crust. For example, about half an hour before the great earthquake at Valparaiso, Chile, on August 16, the seismographs scattered over the globe registered an earthquake of which the center was located in the northern part of the Pacific Ocean. The hourly observations proved that from 31 to 32 minutes elapsed between the two quakes. This is, very approximately, the time occupied by the first derived wave to traverse the diameter of the earth, the length of which is nearly equal to the distance (7,050 miles), in a straight line, between the epicenters of these two earthquakes. Hence the earthquake in the South Pacific may have been the determining cause of the earthquake at Valparaiso.

A consular report which, as might be supposed, comes from Germany, states that the proper color for beer bottles is a matter of some Teutonic concern. It seems that the actinic or chemical rays of light affect beer harmfully. A German authority on brewing has now shown by an exhaustive series of experiments that no form of colored glass when used for beer bottles affords absolute protection against the effects of exposure to sunlight, and that a wide diversity in degree of protection is observed when glass of different tints is employed. The highest measure of protection is yielded by dark, reddish-brown glass. Repeated experiments have shown that while the chromatic changes in the test liquid take place much more rapidly than the alterations in taste and odor of beer under corresponding circumstances, still the retardation in both cases is proportional. Thus a glass bottle which reduced by 50 per cent the action of the actinic rays on the sensitive solution, as compared with a colorless bottle, would likewise involve double the time of exposure for bringing about a given amount of deterioration in the properties of the beer, if filled with that liquid.

Twenty years ago, the loss caused annually by smoke and fog in London was computed to be more than \$22,000,000, divided as follows: Waste of fuel (25 per cent), \$5,000,000; additional cost of laundering and wear and tear of garments, \$10,750,000; damage to outer garments, carpets, and other fabrics, \$5,000,000; loss occasioned by death and illness caused by smoke, \$1,600,000. To this must be added at least \$5,000,000 for the deterioration of mortar, marble, granite, and other stone in buildings, cleaning and painting walls, signs, and shop fronts, corrosion and perishing of metal work, cleaning windows, deterioration and restoration of paintings, engravings, and books, loss of time by artists, photographers, and others whose occupations require abundant daylight, and damage to trees and plants. Further additions should be made for the cost of artificial light and heat made necessary by the darkness, cold, and humidity caused by the obscuration of the sun, the cost of cleaning chimneys, etc. Finally, the smoke causes the metropolis to be shunned by the wealthy classes, and appreciably diminishes the value of real estate. Hence the total annual loss caused by smoke must be about \$30,000,000, or \$5 per capita. Mr. John Graham, who makes this compilation and estimate, appeals to every intelligent citizen of London to lessen his individual contribution to the smoke evil by every means in his power. Graham expresses the opinion that the majority of dwellings might be heated with coke or gas instead of coal, and that the smoke discharged by factories could be greatly diminished by the adoption of smoke-consuming devices that are already on the market.



## A NEW FORM OF TELAUTOGRAPH.

BY DR. ROBERT GUINSHAW.

For more than half a century attempts have been made to produce handwriting at a distance; for instance, Bakewell's apparatus of 1842, Caselli's "Pantograph" of 1856, Gray's of 1888, Amatuzi's of 1893, and Ritchie's and Cerebotani's of later date; while much more recently both Prof. Korn and Herr Karl Grzanna (whom the Germans persist in calling "Gruhn," the name of his former assistant) have been active in this field. As far back as 1904 Grzanna published an account of an apparatus for producing written characters at a distance; and Korn brought out his first selenium cell apparatus in 1906.

Grzanna's apparatus (based on the German patent of the Dresden Klein) as at present constructed consists essentially of the parts here illustrated. The principle of its action is the resolution of every desired stroke of handwriting into a horizontal and a vertical component on the surface on which it is made, and its exact reproduction in the form of the resultant of such components, on the receiving surface. The Cowper apparatus shown at the Paris Exposition of 1878 did the same thing, using a capillary ink tube to form the letters. But in Grzanna's apparatus mirrors are used at the receiving end which throw a beam of light on a sensitive tape. As one mirror swings up and down in the vertical plane, the other in the horizontal from right to left, in the same way as the analyzed movement of the writing, or drawing, point, the resultant of these two mirror movements corresponds to the path of the pencil, at the sender.

Referring to Fig. 1, which represents the principle of the sender,  $t$  is the writing point jointed to a lever arm  $a$ , which is easily movable in all directions in the plane of the writing. The other end of this lever is attached to an arbor  $p$ , which is also movable horizontally in the line  $AB$ , so that the pencil can write freely. A stationary electric resistance is indicated at  $r$ , and a movable resistance,  $s$ , is connected with the lever arm  $a$  by the link shown in the illustration. These two resistances are electrically connected with a battery of eight dry cells. A small current collector,  $b$ , is attached to the movable rod, but is electrically insulated therefrom. At  $c$  is a stationary current collector. These two collectors are electrically connected with the line wires  $d$  and  $e$  respectively. One portion of the battery current flows through the collector into each line conductor; the amount varying with the position of the pencil  $t$ . At each point of the writing surface there are two different but definite current strengths, so that one can say that the movements of the writing operation are converted into changes of current strength. The current returns either through the earth or through a third conductor. At the receiving station it enters the apparatus seen in Fig. 2.

In this there is a small electric lamp  $L$ , that casts its light through a bent tube, with a prism,  $p$ , and a lens,  $f$ , on a small concave mirror,  $a$ , swinging on a horizontal axis; and from this to a second concave mirror,  $s$ , which swings about a vertical axis. From this latter mirror the rays are reflected to a roll of photographically sensitive paper,  $F$ . The horizontal axis of the first mirror,  $a$ , is surrounded by a coil of copper wire in electric connection with the wire  $d$  from the sending station; the vertical axis of the mirror  $s$  being in like manner surrounded by a coil,  $g$ , in electric connection with the other wire,  $e$ . Current in these coils causes vibration of the mirrors, by acting on magnets attached to their axes.

The invisible photographic writing or drawing on the sensitive paper is automatically developed and fixed. After the message is received, the sensitive paper  $D$  is drawn off the roll  $Ph$ , between the pressure rolls and under a yellow glass pane  $G$ , which shuts off the developing chamber of the apparatus. After developing the paper containing the now legible writing or picture passes out between two more pressure rolls. The lower front rolls are rotated by means of worm-wheels in connection with a worm shaft driven by a small motor,  $M$ , the latter, as well as the lamp,  $L$ , being served with current from a small battery,  $B$ . The mechanism is so arranged that after the message is written, the under rolls are rotated until sufficient of the sensitive paper is drawn along toward  $D$ , under the developer-reservoir  $En$ . From this latter, two rubber tubes lead toward two glass strips, lying at an angle to each other on the paper above and thus forming a trough with a small slit below. Through the latter the developing liquid is evenly distributed over the paper  $D$ . The flow of liquid from  $En$  is automatically regulated, and when no paper is ready to be developed,

the rubber tubes are closed by the pressure of an iron plate. At the proper moment an electromagnet relieves the pressure on the tubes and thus allows the developing liquid to flow. The development takes about ten seconds.



Grzanna's telautograph in use.

The apparatus itself can be driven by a dry battery or by an accumulator; about 12 volts being sufficient. Each apparatus is arranged as both receiver and sender. The German post office department has tested the system on the following lines: Berlin-Potsdam, 30 kilometers; Dresden-Meissen, 27 kilometers; Dres-

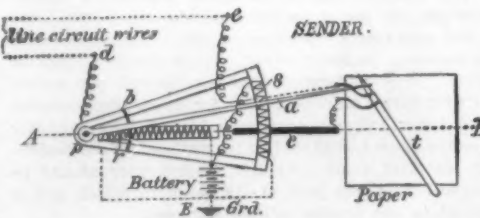


Fig. 1.—Details of the sending apparatus.

den-suburban line, 4 kilometers; and Dresden-Berlin, 200 kilometers.

The remains of a Tyrannosaurus Rex, forty feet long and twenty-two feet in height, have been found in the Bad Lands, south of Glasgow, Mont., by Barnum

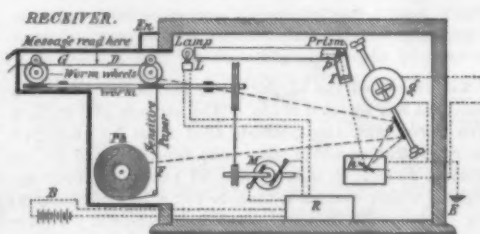
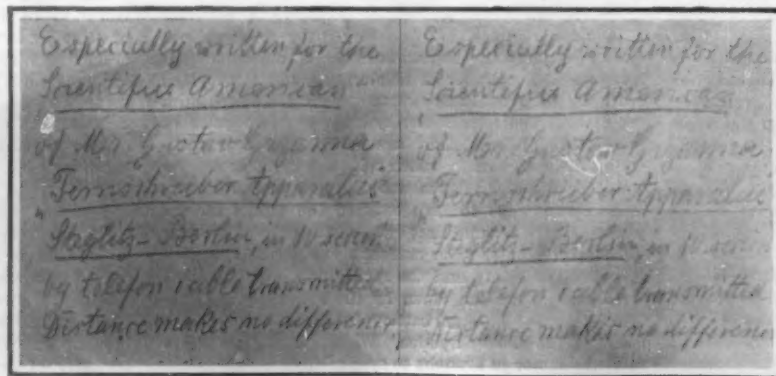


Fig. 2.—Arrangement of the mechanism at the receiving end.

Brown, of New York, connected with the American Museum of Natural History. The relic has been shipped to New York. It took sixteen teams to haul the fossil to the railroad. The skull alone weighs 4,000 pounds. The SCIENTIFIC AMERICAN hopes to publish an illustrated description of this "King of Lizards."



Written by hand.

Reproduced by the receiver.

A sample of the work done by Grzanna's telautograph.

A NEW FORM OF TELAUTOGRAPH.

## The Cullinan Diamond Cut.

The famous Cullinan diamond, the cutting of which was recently described in the columns of the SCIENTIFIC AMERICAN, has been successfully divided into eleven stones. When first discovered, and even before it was cut, the stone was valued at about \$1,000,000, and about that amount was paid for it by the Transvaal government. Fred Wells, the superintendent of the Premier Diamond Company, found the Cullinan diamond in January of 1905. The diamond was a white elephant in its way. Too big and too precious to find a purchaser, the problem of disposing of it perplexed the company not a little. Finally it was decided to present the stone to King Edward, who has intrusted an Amsterdam firm with the splitting and polishing of the gem.

The London Times states that in the original state the Cullinan diamond weighed 3,253 3/4 English karats, or over 11.3 pounds avoirdupois. It is now divided as follows: (1) a pendeloque or drop brilliant, weighing 516 1/2 karats, dimensions, 2.322 inches long and 1.791 inches broad; (2) a square brilliant, weighing 309.3-18 karats, 1.771 inches long by 1.594 broad; (3) a pendeloque, weighing 92 karats; (4) a square brilliant, 62 karats; (5) a heart-shaped brilliant, 18 1/2 karats; (6) a marquise brilliant, 11 1/4 karats; (7) a marquise brilliant, 8.9-16 karats; (8) a square brilliant, 6 1/2 karats; (9) a pendeloque, 4.9-32 karats; (10) ninety-six brilliants, weighing 7 1/2 karats, and (11) a quantity of unpolished "ends," weighing 9 karats.

The first and second of these stones are by far the largest in existence. Even the second is much bigger than the largest previously known brilliant, viz., the Jubilee, weighing 239 karats, while beside either of them so famous a jewel as the Kohinoor sinks into comparative insignificance, since its weight, 102 1/2 karats, is little more than one-third of that of the smaller, or one-fifth that of the larger. Moreover, the stones are not more distinguished for size than for quality. All of them, from the biggest to the smallest, are absolutely without flaw and of the finest extra blue-white color existing.

As regards the two largest, an innovation was made in the manner of cutting. Normally a brilliant has fifty-eight facets. In view, however, of the immense size of the two largest Cullinan brilliants, it was determined to have an increased number, and to give the first seventy-four facets and the second sixty-six. This decision has been abundantly vindicated by the results, for the stones exhibit the most marvelous brilliancy that diamonds can show. This fact is all the more remarkable and satisfactory because very large brilliants are apt to be somewhat dull and deficient in fire.

## Mechanical Stoking.

Many attempts at mechanical stoking have been made in locomotive design, but for different reasons they must still be considered experimental. These attempts have been answers to a crying need for better results than have been obtained from hand firing. Any devices which tend to improve the results of the present system of locomotive firing should, therefore, be well tried out. One of the greatest evils in connection with hand firing is the necessity for the opening of the firebox door, thus admitting large volumes of cold air. In fireboxes which are arranged with baffle plates to protect the tube sheet, cold air from the fire door is not so destructive, but in those which do not furnish this protection, the damage is very great, both to the steaming capacity of the boiler and to the life of the sheets and tube ends. When the firebox door of a hard-working locomotive is opened by hand for the admission of each fire, the aggregate amount of time in which the outside air has free play through the opening is probably as much as twenty-five per cent of that consumed by the trip. There is in use on some roads a device which should

be applied to all locomotives of the heavier types, at least. This device is simply an air door opener and closer. It consists of an air cylinder, the piston rod of which is connected to a lever on the fire door. Air is admitted to the cylinder by a valve operated by the fireman's foot; this drives the piston outward and opens the door. The return is effected by a spring as soon as the air is exhausted. The exhaust takes place automatically when the foot of the fireman releases the valves. The advantage in the use of this device lies in the fact that the time the door must be kept open is reduced. The fireman has the scoop full of coal ready to be discharged immediately the door is opened, and the closing is effected just as quickly.—Railway and Engineering Review.



# CYCLONES ON THE SUN.

BY PROF. S. A. MITCHELL, COLUMBIA UNIVERSITY.

Important discoveries have been made during the past few months at the Carnegie Solar Observatory in California, where Prof. George E. Hale, its director, has gained valuable knowledge about the sun in showing the process whereby fuel is fed into the solar furnace. By improved methods of research, by careful diligence in closely observing the sun, aided by a little stroke of luck, photographs have been taken which show a mass of cool hydrogen gas being sucked into the vortex of a sun spot, the result of a terrific solar cyclone. These critical photographs, which are of excellent quality, speak volumes for the observers on Mount Wilson in regard to their ability in perfecting new lines of research, their hard-working methods in observing, and their genius in properly interpreting the results of these fine pictures. When related, these discoveries appear extremely simple and matter-of-fact, but the work that has led up to them required a series of brilliant discoveries which are probably equaled nowhere in any other science.

Mount Wilson near Pasadena in California was chosen for the observatory of the Carnegie Institution because its position offered the possibility of continuously observing the heavens for weeks at a time unhampered by clouds. The talented director of the Yerkes Observatory of the University of Chicago, chosen as its head, decided to limit observational work to the sun, for the reason that the sun is a typical star, and in closely studying it we are not only gaining information about the body which is of most importance to us on earth, but we are also shedding considerable light on the great and important problem of astronomy, the study of stellar evolution. While still a young man in 1893, Prof. Hale invented the spectroheliograph, and since that time much has been expected from him in astronomic research. His present discoveries are a fitting climax to a long series of brilliant discoveries rendered possible by great genius and remarkable enthusiasm.

If astronomers of the present day had only the photographic camera to assist with their eye observations at the end of a telescope, very little could be known of the sun or its surface. The photographic plate has been of enormous value in giving a permanent record of fleeting phenomena on the sun's surface, and without it the great advances of to-day would have been impossible. Since 1868 the spectroscope has given its aid to solar investigations. In that year Janssen of France and Lockyer of England almost simultaneously pointed out that the red flames or prominences, which formerly could be seen only during the few minutes of a total solar eclipse, were now an everyday phenomenon. By a peculiar use of the spectroscope it is now possible to see these red flames in broad daylight when they are on the sun's edge, in spite of the fact that the light from the sun is a thousandfold more powerful than the light from the prominences. Another field of fruitful research was thus opened, and in the capable hands of the late Prof. Young of Princeton, a long list of discoveries were added to the science of astrophysics. Flames could be seen shooting to enormous distances from the sun's edge at a speed greater than one hundred miles per second! The end of all research seemed nearly reached when it became possible to photograph and obtain a permanent record of these gigantic eruptions, as was possible by Prof. Hale's invention of the spectroheliograph. As the name signifies, the sun is photographed by means of its spectrum. A powerful grating or prism train at the eye end of the telescope spreads the sun's light out into its spectrum. By allowing the light from one line of the spectrum, as *H* or *K*, to pass through a secondary slit, a photograph of the sun and its surroundings can be taken in *H* or *K* light alone. Over-

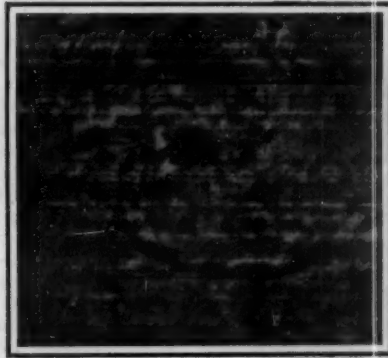
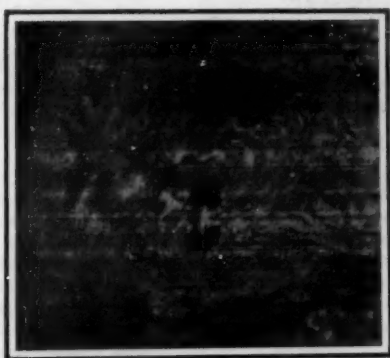
coming the mechanical difficulties involved in this, gave Prof. Hale the spectroheliograph. At first on his 12-inch telescope, later on the 40-inch of the Yerkes Observatory, were photographed wonderful pictures of the prominences at the sun's limb, the sun on the original plates with the 40-inch being seven inches in diameter. With the new spectroheliograph it became possible to photograph not only the prominences but also the face of the sun, and if the secondary slit were set at the center of the *K* line at the violet end of the spectrum, a plate of the sun was obtained in the light of glowing calcium vapor. This photograph was decidedly different in appearance from that of a straight picture taken in the ordinary way.

In experimenting with the spectroheliograph, it was found that the solar image looked different according as the second slit was set directly on the center of the *K* line or a little to the red or the violet side.

tage of a location in California was recognized by the Carnegie Institution. Work there progressed along the same lines which had brought so much success at the Yerkes Observatory; and Prof. Hale planned to carry out researches on a grander scale than was possible even with the 40-inch telescope.

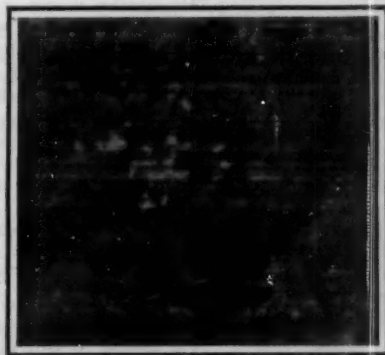
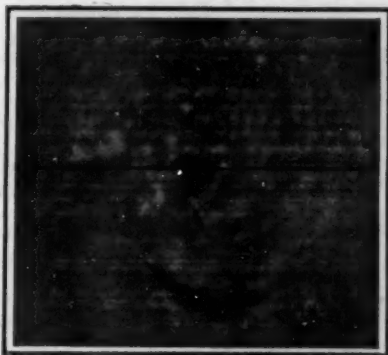
In carrying out the work on the focculi, the greatest success had been obtained in the use of the calcium *H* and *K* lines of the solar spectrum. The hydrogen lines *H $\beta$* , *H $\gamma$* , and *H $\delta$* , were also used to photograph these interesting phenomena, and it was found that there were great differences in the appearance of the sun as the calcium lines were employed or as the hydrogen lines were made use of. In fact, there were marked variations as the sun was photographed in the light of each of these three hydrogen lines. Consequently, Prof. Hale desired greatly to learn what would be the results when the *H $\alpha$*  line of hydrogen was employed. The *H $\alpha$*  or the *C* line of the solar spectrum is the one exclusively used in visual observations of prominences. But unfortunately this *C* line is far in the red, and the ordinary photographic plate is not sensitive to red light, a fact of which we are all aware, since photographs are ordinarily developed in red light. If a plate sensitive to red light could be obtained which would not require too long an exposure, it might then be possible to photograph the sun in the light of glowing hydrogen gas, the *C* line. Experiments to make red-sensitive plates rapid enough for use had not met with much success until within the last year. Mr. Robert James Wallace of the Yerkes Observatory showed a method of doing this by bathing ordinary plates in a certain solution. With this new weapon of research photographic work on the sun was undertaken at Mount Wilson with renewed energy. Seed's "Glit Edge" plates bathed according to Wallace's directions proved to be splendidly adapted to the purpose. The first experiments with the new plates were tried about the middle of March, 1908, though the first satisfactory photograph was that of April 30. The new plates showed a great improvement in detail over the old. Not only were prominences seen better, but the spots on the sun's surface took on an added interest, for it was at once seen that they are centers of attraction which draw toward them the hydrogen of the solar atmosphere. It became necessary now more closely than ever to observe sun spots, for discoveries would follow each other in rapid order.

On May 26, 1908, a spot reached the east limb of the sun at 8:16 A. M. and the looked-for opportunity was at hand. On May 25, before the spot turned the edge of the sun, evidences of activity could be seen in the shape of prominences which were undoubtedly connected with the spot group. On May 28 at 6:58 A. M., with the spot very close to the eastern limb, traces of a cyclone could be seen near the spot, matter there being in rapid whirling motion, and likewise was seen what proved later to be especially interesting, a focculus of dark cool hydrogen. (The spot remained on the face of the sun until June 8.) The splendid series of photographs taken show the cyclones continuing on a gigantic scale around the spot. The dark mass of hydrogen—the focculi—showed changes here and there, giving evidence of great agitation on the sun. Suddenly on June 3 a catastrophe happened; the cool hydrogen gas, which had been continuously in the same location since the spot came around the edge of the sun on May 26, was quickly set whirling and was rapidly sucked into the great maelstrom on the sun. Prof. Hale was lucky enough to have this great solar cyclone—the first of its kind ever seen—recorded on a series of nine photographs all taken within ten minutes. We congratulate Prof. Hale on his energy and his great fortune. The speed at which this cool hydrogen rushed into the center of the spot was about sixty miles per second—rather faster than



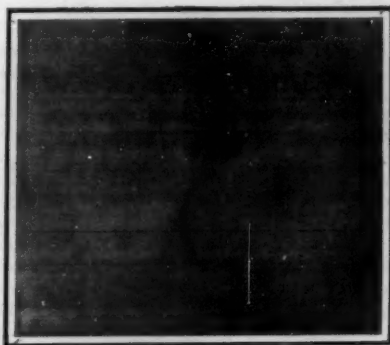
Photographs showing the sunspot on May 29 and June 2, 1908.

Note the long, dark mass of hydrogen and the marked whirling structure.



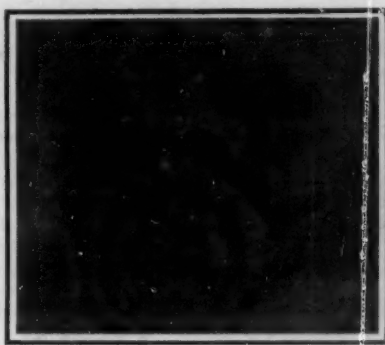
The sunspot on June 3 at 4:58 p. m. and 15 minutes 38 seconds later.

The hydrogen mass is rapidly moving toward the spot.



8 mins. and 6 secs. after last photograph.

Hydrogen mass is being sucked into the vortex.



View on the following morning.

Note radial lines. Whirling structure has disappeared.

Photographs by Prof. Hale.

## CYCLONES ON THE SUN.

This had led to the discovery of focculi by Prof. Hale, masses of luminous gas floating at different elevations above the sun's surface. Still later investigations led Prof. Hale to the conclusion that it was now possible to take photographs representing the condition of the sun's atmosphere at different elevations. When we think that remarkably little is known of our own atmosphere at a height of five miles above the earth's surface, we get a slight idea of the power of the astronomer in photographing the sun ninety-three millions of miles away, and gaining a knowledge of the condition of the sun's atmosphere at different levels! This work was of far-reaching importance, and it became more and more necessary to photograph the sun daily. But at Yerkes and at all observatories in the eastern part of our country, daily work on the sun is often interrupted by clouds, and the advan-



any motions we know of on the earth—a velocity comparable with that at which prominences are thrown off from the sun.

The photographs showing the solar cyclone were taken about 5 P.M. June 3. At 6 the next morning quite a change was evident around the spots. Bright masses of heated hydrogen gas began to appear, and this heated gas kept on increasing in amount for the next couple of days. Thus we become aware of the manner in which relatively cool matter is subjected to the heat of the solar furnace, tracing a mass of hydrogen gas before and after being treated by the solar fire. These are the beginnings of a new set of discoveries which will give us much knowledge regarding our great sun. Spots are thus the centers of disturbances on the sun. But how much disturbance is centered there? And what connection have sun spots with other phenomena? The scientific world has known for more than fifty years that sun spots closely affect the amount of terrestrial magnetism; spots on the sun are connected with "electric storms," and with displays of northern lights, but how related? The sun is evidently the seat of a great electro-magnetic field, whose lines of force stretch outward even as far as the earth. In fact, the appearance of the hydrogen flocculi on the new photographs of Prof. Hale recall to the mind the appearance of iron filings in a magnetic field; and one wishes to know what kind of an electro-magnet the sun is, how it displays its force, and whether sun spots are the centers of lines of force running out. We shall expect Prof. Hale to tell us whether the lines of the spectrum of a sun spot show the Zeeman effect, and how it is that the lines of force from the spot alter the appearance of the spectrum lines.

These discoveries emphasize strongly the great importance of a close and careful study of sun spots, for they are somehow connected with a variety of phenomena such as electric storms, aurora borealis, prominences, flocculi, faculae, corona, and possibly with conditions of temperature or weather here on earth.

#### More Curious Facts About Numbers.

BY J. F. SPRINGER.

Those who read attentively the writer's article on numbers in the *Scientific American* for March 28, 1908, may have wondered how such groups of numbers as (3, 4, 5), (5, 12, 13), (8, 15, 17), and (7, 24, 25) may be obtained. These groups have the property that if their members be squared the sum of the first two squares is equal to the third. Thus  $3^2 + 4^2 = 5^2$ . These few cases were, perhaps without exception, found by observation. But the writer has devised a method whereby an unlimited number of such groups may be obtained with quickness and certainty. Consider the equation

$$[1] \quad (x^2 + y^2)^2 = (2xy)^2 + (x^2 - y^2)^2.$$

Now this equation is true irrespective of the particular values that  $x$  and  $y$  may have. This may be seen by actually carrying out the operations indicated. Thus, squaring as directed, we have,

$$x^4 + 2x^2y^2 + y^4 = 4x^2y^2 + x^4 - 2x^2y^2 + y^4.$$

Returning now to equation [1], and remembering that it is true whatever the values of  $x$  and  $y$ , we may obtain groups of numbers having the desired property by simply selecting any values we choose for  $x$  and  $y$ . Thus, by making  $x = 2$  and  $y = 1$ , we obtain (using dot for multiplication)

$$(2^2 + 1^2)^2 = (2 \cdot 2 \cdot 1)^2 + (2^2 - 1^2)^2.$$

That is,  $5^2 = 4^2 + 3^2$ . This is one of our old groups. Making  $x = 5$  and  $y = 2$ , we obtain

$$(5^2 + 2^2)^2 = (2 \cdot 5 \cdot 2)^2 + (5^2 - 2^2)^2,$$

yielding

$$29^2 = 20^2 + 21^2.$$

Again, making  $x = 8$  and  $y = 3$ , we get

$$73^2 = 48^2 + 55^2.$$

Or, if  $x = 7$  and  $y = 4$ ,

$$65^2 = 56^2 + 33^2.$$

Finally, if  $x = 13$  and  $y = 8$ ,

$$233^2 = 208^2 + 105^2.$$

By performing the operations of squaring, one may convince himself that these results are correct. Thus, in the last case  $233^2 = 54,289$ . The squares of 208 and 105 are 43,264 and 11,025, which upon being added yield 54,289. The reader should use formula [1] and devise groups for himself. By carrying out the squaring operations he may satisfy himself of the correctness of his work.

An interesting property of numbers is the fact that if we add the squares of two consecutive numbers together, we shall obtain a new number such that if we multiply it by 2 and subtract 1, we shall obtain a square number. Thus, suppose we add the squares of the consecutive numbers 2 and 3. Multiplying the new number (13) by 2 and subtracting 1, we get 25—which is a square number. Again, adding the squares of the consecutive numbers 12 and 13, we get 313. Multiplying this by 2 and subtracting 1, we obtain 625—a square number. Indeed, the square number obtained finally is the square of the sum of the two consecutive numbers. Thus, in the first case, 25 is

the square of 5, which is the sum of 2 and 3. So, also, 625 is the square of 25, which is, in turn, the sum of 12 and 13. If we desire to see the reason for this, we may represent the two consecutive numbers by  $x$  and  $x + 1$ . Squaring and adding, we obtain  $x^2 + (x + 1)^2$ , which equals  $2x^2 + 2x + 1$ . Multiplying this by 2 and deducting 1, we get

$$4x^2 + 4x + 1.$$

But this is a square number, being in fact,

$$(2x + 1)^2.$$

This may be written

$$[x + (x + 1)]^2,$$

from which it may be seen that it is the sum of  $x$  and  $x + 1$  which is squared. That is to say, by adding the square of the two consecutive numbers, multiplying the result by 2 and subtracting 1, we get the square of the sum of the consecutive numbers.

In the preceding article, a method was given whereby any cube could be expressed as the difference between two squares. That method utilized the formula

$$[3] \quad x^3 = \left(\frac{x^2 + x}{2}\right)^2 - \left(\frac{x^2 - x}{2}\right)^2.$$

Another method will now be shown, by which we may differently express a cube as the difference between two squares:

Assuming

$$x^3 = y^2 - z^2,$$

we have to determine  $y$  and  $z$ . Instead of factoring  $x^3$  into  $x$  and  $x^2$  (as in the former article), we factor into 1 and  $x^3$ . Putting these equal to the factors of  $y^2 - z^2$ , we have,

$$y - z = 1 \\ \text{and } y + z = x^3,$$

and we obtain for  $y$  and  $z$ :  $y = \frac{x^3 + 1}{2}$ ,  $z = \frac{x^3 - 1}{2}$ .

We may now write,

$$[3] \quad x^3 = \left(\frac{x^3 + 1}{2}\right)^2 - \left(\frac{x^3 - 1}{2}\right)^2.$$

This equation is true, whatever the value of  $x$ , as may be readily shown by performing the operations indicated. As formula [3] stands, it is applicable only to odd values of  $x$ . For, if  $x$  is even, then  $x^3$  is also even. This would make  $x^3 + 1$  and  $x^3 - 1$  odd numbers.

Consequently  $\frac{x^3 + 1}{2}$  and  $\frac{x^3 - 1}{2}$  would remain fractions.

If  $x$  be taken equal to 13, we shall have

$$13^3 = \left(\frac{13^3 + 1}{2}\right)^2 - \left(\frac{13^3 - 1}{2}\right)^2$$

That is  $13^3 = 1,093^2 - 1,092^2$ . Again,

$$7^3 = \left(\frac{7^3 + 1}{2}\right)^2 - \left(\frac{7^3 - 1}{2}\right)^2$$

or,

$$7^3 = 173^2 - 171^2$$

As formula [2] is good for all numbers, whether even or odd, it will be interesting to express by it means the cubes last used ( $13^3$  and  $7^3$ ) as the difference between two squares.

$$\text{Thus, } 13^3 = \left(\frac{13^3 + 13}{2}\right)^2 - \left(\frac{13^3 - 13}{2}\right)^2$$

$$\text{And } 7^3 = \left(\frac{7^3 + 7}{2}\right)^2 - \left(\frac{7^3 - 7}{2}\right)^2$$

These give,  $13^3 = 91^2 - 78^2$

And,  $7^3 = 28^2 - 21^2$ .

An interesting property of the natural numbers is that if we add any number of these together beginning with unity, double the sum and subtract the last of the numbers, we shall have the square of this final number. Thus, suppose we consider the numbers from 1 to 9. Adding,  $1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9$ , we get 45. Doubling this and subtracting the final number (9), we get 81, which is the square of the final number. To understand the reason for this is not difficult. Thus, we write

$$S = 1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9$$

And,  $S = 9 + 8 + 7 + 6 + 5 + 4 + 3 + 2 + 1$ .

Adding we get  $2S = 9(9 + 1)$ .

Expressed more generally,  $n$  being both number of terms and last term, we have

$$2S = n(n + 1) = n^2 + n.$$

We have therefore

$$2S - n = n^2 + n - n = n^2.$$

We will now pass to some theorems which, so far as the writer is aware, appear now for the first time. The first theorem is to the effect that if we have the fifth power of any number (not itself a multiple of 11), we may, by the addition or subtraction of unity, make this number divisible by 11. For instance, the fifth power of 921 is 662,671,283,348,601. By adding 1, it is divisible by 11. Search as you may, you will find no number (unless it itself is a multiple of 11) which upon being raised to the fifth power will not become divisible by 11 upon the addition or subtraction of 1.

In order to establish this result generally, let us represent any number (not containing 11 as a factor) by  $x$ . Now this number  $x$  upon being divided by 11, will yield a remainder less than 11 and more than 0 (as it is supposedly not divisible by 11). We may write, therefore,

$$x = 11y + z,$$

where  $z$  may have any integral value from 1 to 10 (inclusive). We now write,

$$x^5 = (11y + z)^5.$$

This gives, by ordinary algebra,

$$x^5 = 11^5 y^5 + 5 \cdot 11^4 y^4 z + 10 \cdot 11^3 y^3 z^2 + 10 \cdot 11^2 y^2 z^3 + 5 \cdot 11 y z^4 + z^5.$$

If we attentively observe the right-hand side of this equation, we shall see that 11 occurs in all the terms except the last. We may write, then,

$$[4] \quad x^5 = 11 \cdot R + z^5.$$

Now, as before observed,  $z$  is limited in its range of values. Let us examine these

For $z = 1$ , $z^5 = 1$	$= 11 \times 0 + 1$
$z = 2$ , $z^5 = 32$	$= 11 \times 3 - 1$
$z = 3$ , $z^5 = 243$	$= 11 \times 22 + 1$
$z = 4$ , $z^5 = 1,024$	$= 11 \times 93 + 1$
$z = 5$ , $z^5 = 3,125$	$= 11 \times 284 + 1$
$z = 6$ , $z^5 = 7,776$	$= 11 \times 707 - 1$
$z = 7$ , $z^5 = 16,807$	$= 11 \times 1,528 - 1$
$z = 8$ , $z^5 = 32,768$	$= 11 \times 2,979 - 1$
$z = 9$ , $z^5 = 59,049$	$= 11 \times 5,368 + 1$
$z = 10$ , $z^5 = 100,000$	$= 11 \times 9,091 - 1$

It will be seen, from an examination of the last column, that  $z^5$  may always be expressed as a multiple of 11 plus or minus 1. That is, we may write

$$z^5 = 11 \cdot M \pm 1.$$

Consequently, equation [4] may now be written

$$x^5 = 11 \cdot R + 11 \cdot M \pm 1.$$

From which is easily obtained,

$$x^5 \mp 1 = 11 \cdot (R + M).$$

That is to say, either the addition or subtraction of unity will cause any fifth power to become divisible by 11, unless the number raised to the fifth power is itself a multiple of 11, when the addition or subtraction of no number is needed to make it divisible by 11.

This seems to be a very curious result. Another apparently new proposition affirms that if we subtract a number from its seventh power the result is divisible by seven. Thus 128 is the seventh power of 2. Subtracting 2, we get 126, which is divisible by 7. Again, 279,936 is the seventh power of 6. Subtracting 6, we obtain 279,930, which upon trial we find to be divisible by 7. As a final illustration, consider the number 62,748,517. This is the seventh power of 13. Subtracting 13 from it, we get 62,748,504, which is divisible by 7.

In order to establish this proposition generally, let  $x$  represent any number not divisible by 7. It is superfluous to consider multiples of 7, as the proposition is obviously true in their case. So then, we have to prove that

$$x^7 - x$$

is divisible by 7, when  $x$  is a non-multiple of 7. As  $x$  is not divisible by 7, we may write

$$x = 7y + z, \text{ when } z \text{ varies from 1 to 6 (inclusive).}$$

We have, then,

$$x^7 - x = (7y + z)^7 - (7y + z).$$

Now, upon expanding the right-hand side of this equation the number 7 appears in every term except  $z^7$  and  $-z$ . So that we may write

$$[5] \quad x^7 - x = 7 \cdot Q + z^7 - z.$$

Let us consider the possibilities of  $z^7 - z$  for the six possible values of  $z$  (1 to 6).

For $z = 1$ , $z^7 - z = 0$
$z = 2$ , $z^7 - z = 126$
$z = 3$ , $z^7 - z = 2,184$
$z = 4$ , $z^7 - z = 16,380$
$z = 5$ , $z^7 - z = 78,120$
$z = 6$ , $z^7 - z = 279,930$

Examining the column on the right hand, we find every number to be divisible by 7. Consequently, whatever value it is possible for  $z^7 - z$  to possess, each and every one is divisible by 7. So that the right-hand side of equation [5] is divisible by 7, throughout—which establishes the proposition.

A similar proposition, and one apparently new, is to the effect that if we subtract a number from its thirteenth power the resulting number is divisible both by 7 and 13, and consequently by 91 (since  $7 \times 13 = 91$ ). As an example, consider the thirteenth power of 2. This is 8,192. Subtracting 2, we obtain 8,190, a number divisible both by 7 and 13. Again, the number 2,541,865,828,329 is the thirteenth power of 9. Subtracting 9, we have, 2,541,865,828,320. This number, upon trial, we find to be divisible both by 7 and by 13. These seem to be pretty striking results. But perhaps some one may question whether they are not mere matters of coincidence.

To prove the fact generally, let us denote the number, whose thirteenth power is to be taken, by  $x$ . We have, then, to show that  $x^{13} - x$  is divisible both by 7 and by 13. As the proposition is self-evident, as far as 13 is concerned, if  $x$  is a multiple of 13, we shall consider that  $x$ , upon division by 13, yields a remainder less than 13. That is,

$$x = 13y + z.$$

Where  $z$  varies from 1 to 12 (inclusive). We write now,

$$x^{13} - x = (13y + z)^{13} - (13y + z).$$



The entire right-hand side of this equation contains 13 as a factor except

Let us consider the possible values of this expression.  
For  $x = 1$ ,  $x^{13} - x = 0$   
 $x = 2$ ,  $x^{13} - x = 8,190$   
 $x = 3$ ,  $x^{13} - x = 1,594,320$   
 $x = 4$ ,  $x^{13} - x = 67,108,860$   
 $x = 5$ ,  $x^{13} - x = 1,220,703,120$   
 $x = 6$ ,  $x^{13} - x = 13,060,694,010$   
 $x = 7$ ,  $x^{13} - x = 96,889,010,400$   
 $x = 8$ ,  $x^{13} - x = 549,755,813,880$   
 $x = 9$ ,  $x^{13} - x = 2,541,865,828,320$   
 $x = 10$ ,  $x^{13} - x = 9,999,999,999,990$   
 $x = 11$ ,  $x^{13} - x = 34,522,712,143,920$   
 $x = 12$ ,  $x^{13} - x = 106,993,205,379,060$

Examining the column of figures at the right hand, it will be seen that each and every number is divisible by 13. Consequently, the expression  $x^{13} - x$  is divisible by 13. We have yet to show that it is also divisible by 7. We represent  $x$  now by  $7m + n$ , where  $n$  may be any number from 1 to 6. The expression  $x^{13} - x$  now becomes

$$x^{13} - x = (7m + n)^{13} - (7m + n)$$

Just as before, every term on the right-hand side, when expanded, contains the factor 7 except the expression

$$n^{13} - n$$

To examine this for values from 1 to 6, is simply to look over the column of figures last obtained beginning with the first and extending through the sixth, to see whether 7 is a factor. Upon examination, we find that it is. So that as a result of our investigation we find that all numbers of the form  $x^{13} - x$  are divisible both by 7 and by 13—consequently by  $7 \times 13$ , or 91.

But we have not reached the end as yet. In raising numbers to the several powers, we find that powers of numbers ending in 1 also end in 1. Thus, any power of 31 will terminate in the figure 1. If a number ends in 2, the final figure of its various powers runs through the cycle 2, 4, 8, 6. Constructing a table, we find the following results:

Final Figures.	Powers.					
	1	2	3	4	5	6
1	1	1	1	1	1	1
2	2	4	8	6	2	4
3	3	9	7	1	3	9
4	4	6	4	6	4	6
5	5	5	5	5	5	5
6	6	6	6	6	6	6
7	7	9	3	1	7	9
8	8	4	2	6	8	4
9	9	1	9	1	9	1
0	0	0	0	0	0	0

Thus for numbers ending in 7, the final figures of the powers run through the cycle 7, 9, 3, 1. Upon examining the table closely, it will be seen that these cycles consist of one, two, or four numbers. In consequence of this periodicity, the thirteenth power of any number will terminate in the same figure as the first power, all the cycles starting afresh at this power (as also at the fifth and ninth). Consequently, if we subtract the first power from the thirteenth we shall obtain a number whose final figure is 0—the final figures of minuend and subtrahend being the same. Consequently, all numbers of the form  $x^{13} - x$  terminate in 0, and are for this reason divisible by both 2 and 5. We learn, then, that all numbers of the form  $x^{13} - x$  are divisible at once by 2, 5, 7, and 13—that is, by 910.

#### The Current Supplement.

The opening article of the current SUPPLEMENT, No. 1716, deals with the subject of the short-distance transportation of the products of the mine, field, and forest from the outlying districts to the railroad. The use of dry air in the blast furnace as patented by Gayley is described fully. Various conjectures have been made as to the cause of the destruction of Count Zeppelin's airship. One very plausible explanation ascribes the catastrophe to the effect of atmospheric electricity. The electrical principles involved are described in the SUPPLEMENT. Whether as a toy, as a scientific instrument, or as an object of practical utility, the gyroscope is of great interest. As an illustration of its possible development, a gyroscope invented by Prof. Ach of Berlin is described, which has for its object a means of securing the invariability of the axis of rotation of the gyroscope, no matter what arbitrary movements may take place in the carrier of the gyroscope. The invention comprises means to do away with the influence of gravity on the spinning body. Sir William Ramsay discusses the subject, "Do the Radioactive Gases Belong to the Argon Series?" The making of artificial diamonds is described. Mr. Alexander A. Chenoweth writes on reinforced concrete as a substitute for wooden piles, cross-

ties, or sleepers. Photographic bird's eye views have hitherto been obtained by means of balloons, or kites. Dr. Neubronner has discovered that they may also be taken with the aid of carrier pigeons. The necessary apparatus is described and illustrated.

#### A \$500 Prize for a Simple Explanation of the Fourth Dimension.

A friend of the SCIENTIFIC AMERICAN, who desires to remain unknown, has paid into the hands of the publishers the sum of \$500, which is to be awarded as a prize for the best non-mathematical explanation of the Fourth Dimension, the object being to set forth in an essay the meaning of the term so that the ordinary lay reader can understand it.

Competitors for the prize must comply with the following conditions:

1. No essay must be longer than 2,500 words.
2. The essays must be written as simply, lucidly, and non-technically as possible.
3. Each essay must be typewritten and identified with a pseudonym. The essay must be inclosed in a plain sealed envelope, bearing only the pseudonym. With the essay should be sent a second plain sealed envelope, also labeled with the pseudonym, and containing the name and address of the competitor. Both these envelopes should be sent to "Fourth Dimension Editor, SCIENTIFIC AMERICAN, 361 Broadway, New York, N. Y."
4. All essays must be in the office of the SCIENTIFIC AMERICAN by April 1, 1909.
5. The Editor of the SCIENTIFIC AMERICAN will retain the small sealed envelope containing the address of the competitor and forward the essays to a Board of Judges, who will select the prize-winning essay.
6. As soon as the Board of Judges have agreed upon the winning essay, they will notify the Editor, who will open the envelope bearing the proper pseudonym and containing the competitor's true name. The competitor will be notified by the Editor that he has won the prize, and his essay will be published in the SCIENTIFIC AMERICAN.
7. The Editor reserves the right to publish in the columns of the SCIENTIFIC AMERICAN or the SCIENTIFIC AMERICAN SUPPLEMENT three or four of the more meritorious essays, which in the opinion of the judges are worthy of honorable mention.

The Editor of the SCIENTIFIC AMERICAN is now engaged in selecting the judges who will award the prize. They will be three in number, and all will be eminent American mathematicians. The names of the judges will be announced in a later issue of this journal.

#### Substitute for Chromate of Silver.

Running short of Lord Kelvin's glass tubes for deep-sea soundings, and finding the prices charged in America—40 cents each—rather high, Mr. John Martin of the S. S. "Akershus" informs us that he tried to find some substitute for chromate of silver, and succeeded. He bought a  $\frac{1}{4}$ -inch (inside diameter) water-gage glass of the same length as Lord Kelvin's tubes, closed one end with a flat piece of cork, a small rag over it and some sealing wax. Next he cut a sheet of drawing paper into narrow strips at a bookbinder's. Along the middle of the paper strip he drew a line with a copying pencil. The paper slip was then shoved up the glass tube, forming a blank scale. The lower end of the strip was turned around the edge of the tube and tied with a piece of cotton thread to prevent the paper from being displaced by the water as it rose in the tube. The tube was used in the same way as Lord Kelvin's. The depth was read off from the boxwood scale. The ink pencil line distinctly indicated how far the water reached. The guard tube containing the gage glass was made from an old condenser tube.

#### The Death of William Edward Ayerton.

William Edward Ayerton, the distinguished English electrical engineer and inventor, died in London on November 8 in his sixty-first year. He was educated at University College, London, and after graduation entered the Indian Government Telegraph Service. In 1873 he was appointed to the chair of natural philosophy and telegraphy at the Imperial College of Engineering, Japan. Here he remained for five years. In 1884 he was made professor of electrical engineering at the Central Technical College, South Kensington. He was president of the Physical Society, 1891-2, and president of the Institution of Electrical Engineers in 1892.

#### The Death of John Henry Mills.

John Henry Mills, a pioneer heating engineer and inventor of heating boilers, of Boston, Mass., died at his home in Faneuil, a suburb of that city, on Tuesday, October 6, in his seventy-fifth year. He was an authority on heating, and his work, "Heat—Its Application to the Warming and Ventilation of Buildings," is one of the standard books on the subject.

## Correspondence.

### USEFUL ARTIFICIAL WATERWAYS.

To the Editor of the SCIENTIFIC AMERICAN:

The proposition to retain water at the heads of large rivers and their tributaries is surely well worth careful consideration, as it will aid in retaining moisture, not only on the surface, but to great depths, replenishing old-time underground rivers and furnishing water for wells in the surrounding country. Such reservoirs can be used to keep machinery running during the dry season too, thus adding millions of dollars valuation to power plants, by steady business, in regulating production so as to secure equal results throughout the whole year.

Yet still all the water that can be retained will prove to be an infinitesimal quantity in checking the overflow of the lower streams of any great system of rivers, such as the Mississippi and the Amazon.

The best possible commend of the Mississippi River can be secured by dredging a deep and broad channel for several hundred miles inland at a proper distance from the river channel on both sides of the river.

The channel on the west side should extend from Atchafalaya Bay, keeping west of the extremely troublesome Bayou Lafourche and passing east of Opelousas and Alexandria, La., east of Pine Bluff, Ark., on to the head of White River, across the line of Missouri, to a point opposite Charleston near the Mississippi River, and Van Buren on the Iron Mountain Railway. This will drain large tracts of wet, unproductive flat lands, which will be of excellent quality and most of them fertile and productive when properly drained. There are hundreds of thousands of acres of flat, wet land along the proposed course of this west side canal.

The east side channel should begin at Bay St. Louis, extending north, crossing the Pearl River, to a point above Lake Pontchartrain. There bending west should cross the Illinois Central Railway, near the town of Amite, reaching the Mississippi Valley a few miles below Natchez, on into the Yazoo Valley, then on up that valley, passing near and east of Memphis and on to the Ohio River Valley. There bending east follow the course of that river as far as the land formation makes it desirable. At certain points it may be necessary to leave off one side of a river and take up construction on the other side. This being a question of easy decision for any competent engineer.

These channels will have a threefold purpose of usefulness: First, as channels of drainage, they will add several hundreds of millions of dollars value to the country traversed, by providing several outlets for drainage of swamps and farm land in general. For such an outlet there is a burning necessity which should have been provided for long years ago.

Second, for relieving the strain upon the levees of the Mississippi and the other rivers and bayous included in the districts traversed by the canals, also to prevent overflow by letting surplus water into these channels, through intersecting canals at any point of greatest strain. This can be done at any point where cross-sectional channels have been constructed.

Third, if set free to the traffic of all who own suitable crafts, the value for purposes of navigation alone will eventually pay the cost of construction and fat dividends besides.

These main channels can be constructed a liberal width in the beginning and shallow, to be deepened by dredging until, if found desirable, seagoing vessels of the highest tonnage can pass each other with ease, and take their loads inland to the head of these canals.

On the east side of the Mississippi River, beginning about 30 miles above Cairo and extending up to St. Louis, is an extensive bottom-land country, which would be tripled in value by a canal of sufficient capacity to carry off the local surplus water, and aid in relieving the Mississippi whenever a threatened overflow at that part of its course created a call for an extra outlet.

Between Omaha, Neb., and St. Joseph, Mo., a good deep and broad canal would aid greatly in preventing the destructive overflowing and changing of channel of the Missouri River.

At Kansas City, too, relief from inundations of the lower portions of that city can be secured by one or two canals of capacity requisite for drawing off the surplus water whenever a surplus approaches with all its threatened consequences.

On the middle and upper Ohio, along the rivers of Kansas, wherever there is a necessity in localities mentioned or others not named; wherever are found large rivers or threatening streams subject to extraordinary floods, in any part of the world, this proposed plan will bring security from ordinary enervating disastrous consequences. Think for a little how much this means.

From the northwest corner of Lake Pontchartrain a cypress swamp extends north for many miles. This swamp has water nearly all over its surface, for the greatest part of the year. If drained, it would soon become farm land of great value on account of its fertility. This can all be drained by one canal and a levee along the shore of the lake, then pump the water over the levee into the lake.

Many other similar localities can be reclaimed in like manner. The above proposed system is of vast and far-reaching importance, and should be carefully investigated at the earliest possible opportunity afforded to those upon whom the responsibility devolves, and whose duty it is to have this work of altogether unprecedented importance performed.

Whose duty should it be, if not the unbought duty of the people, all the people, of the great republic, the United States of America? Every citizen of this whole country should be interested. This work will benefit all of them, both individually and collectively.

J. A. STOCKFORD.

Spokane, Wash., November 2, 1908.

From the returns compiled by Lloyd's Register, it appears that, excluding warships, there were 319 vessels of 733,378 tons gross under construction in the United Kingdom at the close of September, 1908.



### AN AEROPLANE FACTORY.

BY JACQUES BOYER.

The construction of aeroplanes is the latest new industry to be started in France; and the exploits of Santos Dumont, Bleriot, Farman, Delagrangé, and the Wright brothers, by focusing public attention upon aviation, have aided in its development. As a result,

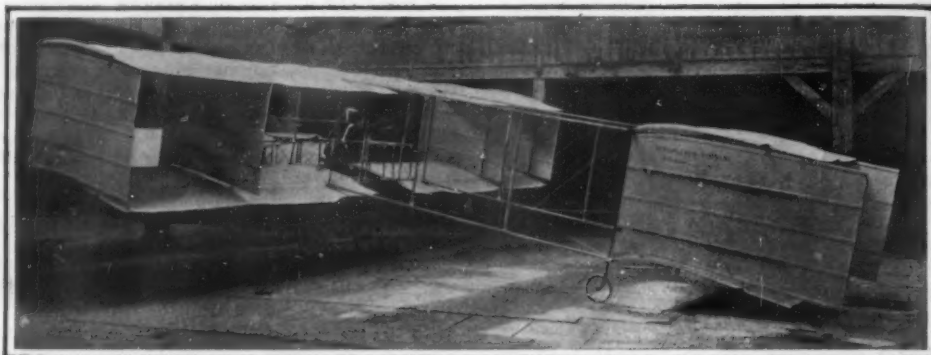
are of the same material or of poplar. The main longitudinal pieces are cut from very dry wood. They are about 32 feet long, and are selected so that the grain runs from one end to the other, in order to give a maximum resistance for a given section. They are planed down and grooved in certain places, and then fitted together by means of uprights that are mounted

in aluminium sockets attached to them. The framework thus formed is suitably braced by means of steel piano wire, drawn taut and fastened to eyelets in the aluminium sockets. In the aeroplanes of the Farman type constructed by Voisin, the finished body framework has a total length of  $9\frac{1}{2}$  meters (31.16 feet), weighs 55 kilogrammes (121 $\frac{1}{4}$  pounds), and is



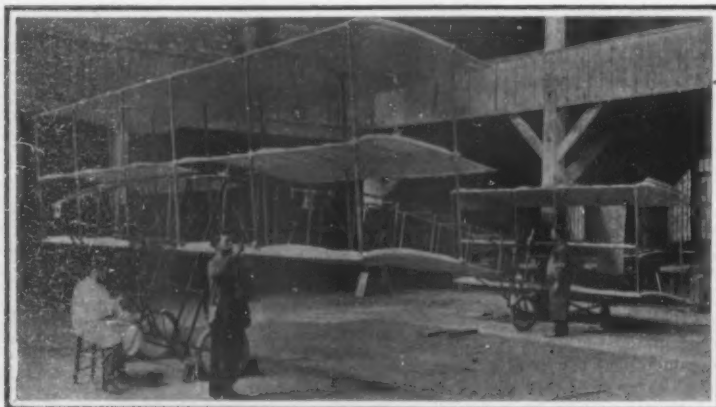
Covering the frame of a plane with cloth.

A waterproof cloth having pockets for the ribs is used to form the planes.



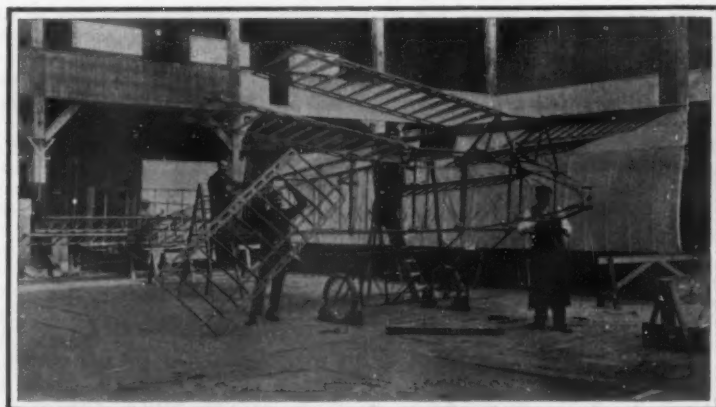
Farman's aeroplane, showing some of the recent changes in its construction.

Vertical partitions have been placed half way between the center and ends, and also at the ends of the main planes. They prevent the machine from skidding sideways when turning a corner.



The Goupy three-decker. This machine was tried without encouraging results.

The use of three superposed surfaces makes it possible to reduce the spread of the planes considerably.



Assembling the "Flying Fish," Farman's untried following-plane machine.

This arrangement of following planes also makes possible the reduction of the wing spread.



Side members of the main body frame of an aeroplane.

there are to-day several factories especially fitted up for this purpose near Paris. The most important of these, that of Voisin brothers at Billancourt, has a capacity of four machines a month.

In the principal room of this original factory are found scattered about the various parts of aeroplanes in course of construction. In one corner is to be seen the body framework or skeleton of a future aerial vehicle, some 36 feet in length by about  $2\frac{1}{2}$  feet in width, while a little farther on are placed the cells, or enormous wings, having a spread of some 32 feet and intended to be mounted on monoplane, double or triple-surface machines.

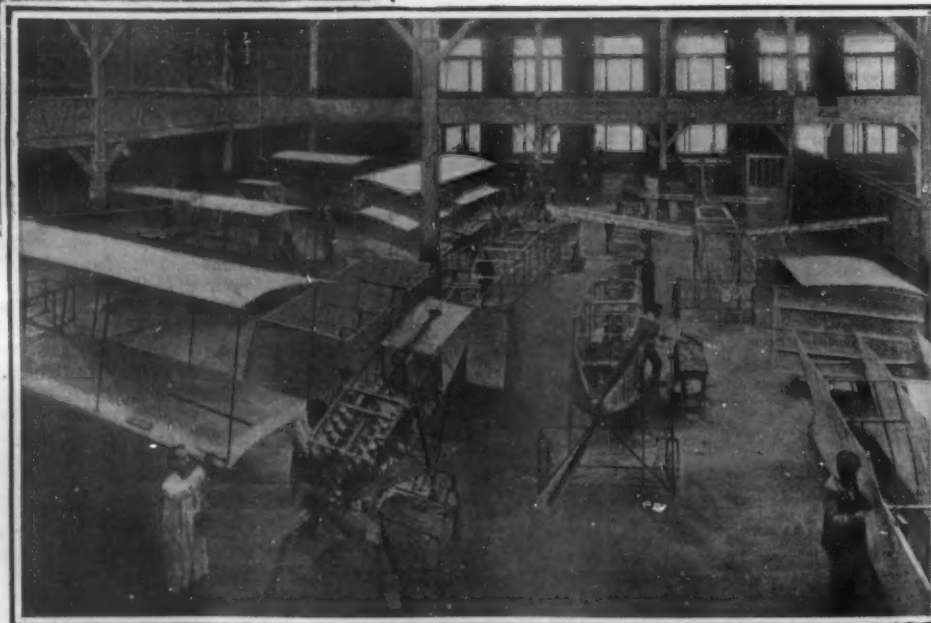
The tools used in the aeroplane factory are of the simplest sort. They consist of mallets, saws, chisels, and such other tools as are used by carpenters. The wood used in making the body framework is generally oak, while the uprights that connect the main planes

so rigid that it will support a weight of over 1,000 pounds at its front end.

The body framework tapers at the front and terminates in a steel and aluminium plate, in the center of which is fastened the bearing for the propeller shaft. The motor is mounted on a metal frame, and the seat of the aviator consists of a board with a back attached.

The cells or wings, which are attached to each side of the body framework, consist, in the case of a double or a triple-surface machine, of two or three superposed surfaces, connected together by poplar uprights mounted in the aluminium sockets, and braced by steel wires in order to make them sufficiently rigid. These surfaces are made up of a frame consisting of two strips of wood (one in front and one at the back) connected by curved ribs of poplar, and covered with rubber-impregnated cloth, which is nailed to the strips

(Concluded on page 358.)



Interior of the Voisin factory, showing finished aeroplanes and others in course of construction.

THE CONSTRUCTION OF AEROPLANES.

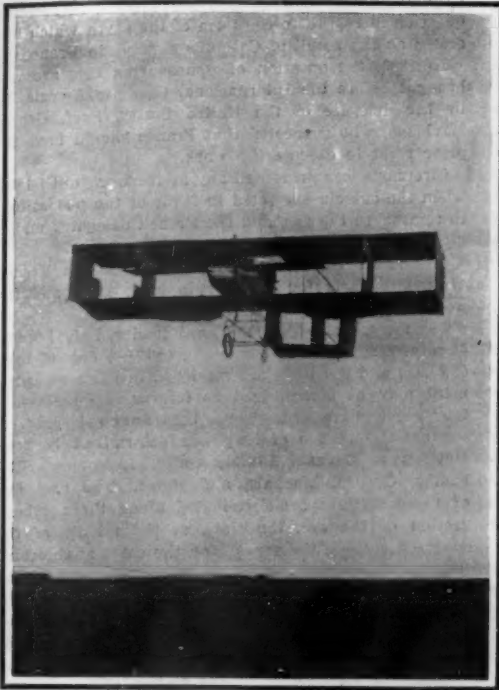


**THE LATEST EUROPEAN AIRSHIPS AND AEROPLANES AND THEIR PERFORMANCES.**

As noted in our issue of October 31, Count Zeppelin, on the 23d ultimo, brought out his fifth airship for its first trial. One of our illustrations shows this huge air craft undergoing its first trial. The new airship is the remodeled "Zeppelin III." of 1906, which,

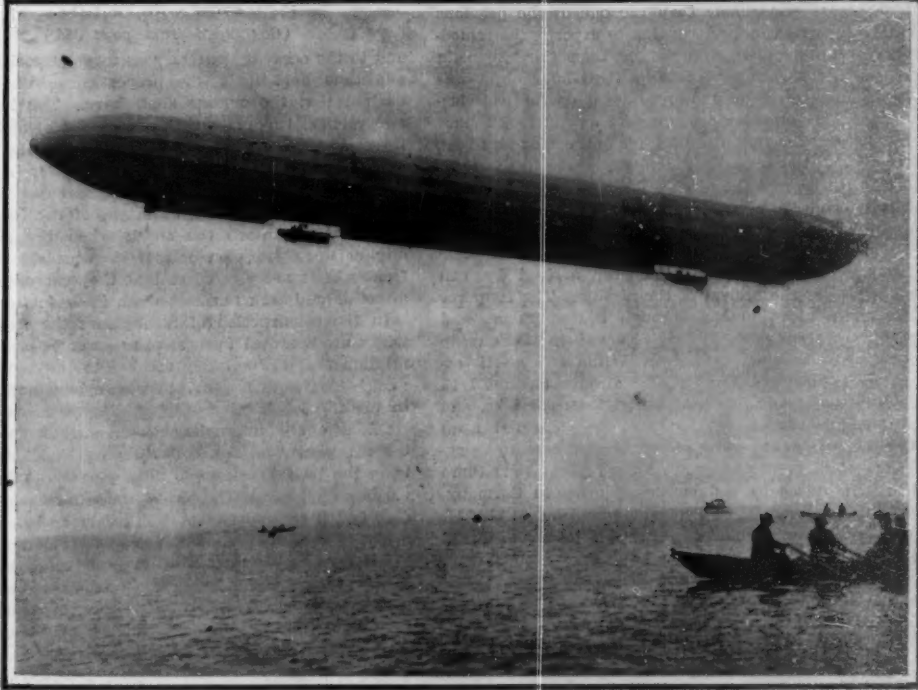
before the building and operation of the fourth airship last year, had shown remarkable results. It has been lengthened out 8 meters (26¼ feet), and, because of its smaller diameter than the No. 4, Count Zeppelin has used two 85-horse-power motors in place of the 110-horse-power engines that were on the later airship. The remodeled No. 3 has the same inclined

stabilizing planes attached to its sides at the rear that were first tried out upon it and afterward used in a modified form upon the No. 4, but in place of the very large vertical rudder the latter had at its rear end, small triple vertical rudders only appear to be used between the stabilizing planes on each side. A three-surface horizontal rudder is used on each side



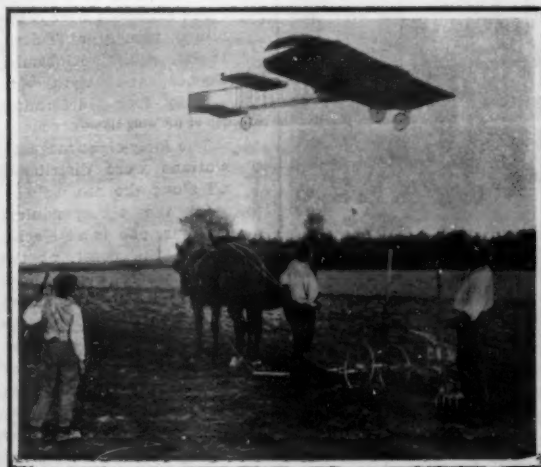
**Farman's aeroplane flying across country.**

Note the vertical partitions connecting the planes. These have been added recently.



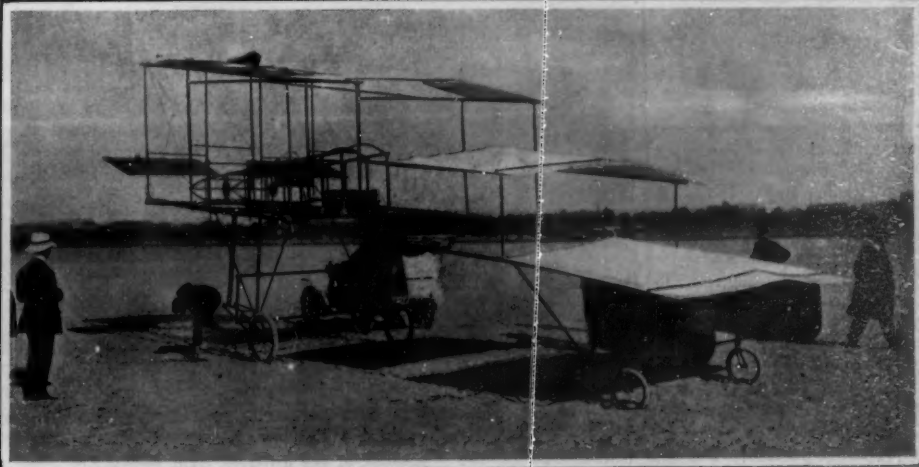
**The latest Zeppelin airship--the remodeled No. 3--in flight above Lake Constance.**

The large vertical rudder at the rear has been dispensed with and replaced by small triple rudders on each side.



**Bleriot's monoplane on its nine-mile cross-country flight.**

Despite numerous accidents, this machine has proved its worth by its flights across country and in a strong wind.



**Three-quarter rear view of the Witzig-Moré-Dutillieu aeroplane.**

Note the step-like arrangement of the surfaces, with the horizontal rudder in front and the twin vertical rudders at the rear.



**The Clement dirigible sailing over the Madeleine in Paris on its initial trip.**

Note the aluminium cabin in the body framework.



**The new Clement airship, showing the peculiar tall, the propeller, and the horizontal and vertical rudders.**

During its maiden voyage on October 29, this new airship, piloted by M. Kapferer, carried seven people from Sartrouville to Paris and back at a speed of between 25 and 30 miles an hour.



of the bow also. Among the new features is a telegraph line connecting the two cars.

A few of the recent flights of the remodeled airship are enumerated below. The first was made on October 23, when the airship flew over Lake Constance and the city of the same name about four hours. On the next day a flight of two hours was made, and on Sunday, the 25th of October, another two-hour flight much more remarkable than the one of the previous day was carried out. According to experts, the remodeled vessel operates even better than the "Zeppelin IV." On the 26th of October a three-hour flight was made, but one of the motors did not operate satisfactorily. The following day, Count Zeppelin took Prince Henry of Prussia with him for an extended flight, which lasted six hours. A trip was made to the Falls of the Rhine, and the airship developed a speed of 50 kilometers (31 miles) an hour. Several days after, on November 7, Crown Prince Frederick William accompanied the Count, and made a trip to Donaueschingen, Baden, where the Emperor arrived by rail shortly after the arrival of the airship. The Emperor conversed with his son through a megaphone, and afterward the Crown Prince returned in the airship to Friedrichshafen. Emperor William himself expected to make a trip in the airship on the 10th instant, but instead he watched it from the lake, and at the termination of the flight he conferred upon Count Zeppelin the order of the Black Eagle, in recognition of his achievement. At the present time there has been raised by popular subscription in Germany, for the construction of Zeppelin dirigibles, \$1,378,334. This gives a good idea of the decided success Count Zeppelin has finally met with among his countrymen.

The other dirigible which we illustrate is the "Clement-Bayard" of M. Clement, the well-known automobile manufacturer of Paris. This airship has been constructed for the personal use of M. Clement. It is 56 meters long (183.6 feet) by 10.58 meters (34.7 feet) in diameter, and it has a capacity of 3,500 cubic meters (123,602 cubic feet). The body framework is 28½ meters (93½ feet) long, made of steel tubing. A triple-surface horizontal rudder is placed at the forward end of the body framework, and a 5-meter (16½-foot) propeller is at the extreme front end. The 120-horse-power Bayard-Clement motor is mounted on springs, and drives the propeller 380 R. P. M. by reduction gearing. Every conceivable kind of indicating apparatus has been fitted. For example, there is a tachometer which gives the number of revolutions of the motor at every instant. For the convenience of the passengers a closed cabin of sheet aluminium has been provided. A specially noticeable feature of this dirigible is the peculiar tail, which consists of four club-shaped gasbags placed beside the reduced rear end of the main envelope. This form of tail has been found to work quite satisfactorily, and to give the balloon a considerable degree of stability. M. Clement expects to use this airship in making excursions to his country place.

Two of the photographs reproduced herewith show Farman's remodeled aeroplane and the latest Bleriot monoplane in full flight. The Farman machine has been changed by the placing of vertical partitions at the ends of the main planes and by the moving of the partitions that were formerly on each side of the center part to points about half way between the center and the ends of the main planes. M. Farman has also fitted horizontal auxiliary planes or shutters to the rear edges of both the upper and lower planes. The angle of these shutters can be varied to tilt up the machine when turning a corner. After making the sensational cross-country flight mentioned elsewhere, Farman, on October 31, won the "Prix de la Hauteur" of the Aero Club of France by flying over a line of captive balloons placed at a height of 82 feet. The Bleriot monoplane has not been changed very much of late. The movable wing tips are still used on the ends of the plane, and there is but a single horizontal rudder below the rear end of the body framework. A small additional plane is fitted above the body framework toward the rear. These rudders and movable wing tips apparently work very well, since M. Bleriot was able, on October 22, to drive his machine against a strong wind of between 25 and 30 miles an hour. The speed of the machine itself is about 37 miles an hour.

The other aeroplane we illustrate is a new type, in which the surfaces are arranged in a series of steps. This aeroplane is known as the Witzig-Dutilleul. It has a total surface of 50½ square feet, and is to have a 50-horse-power Antoinette motor. No experiments of any account have as yet been made with it.

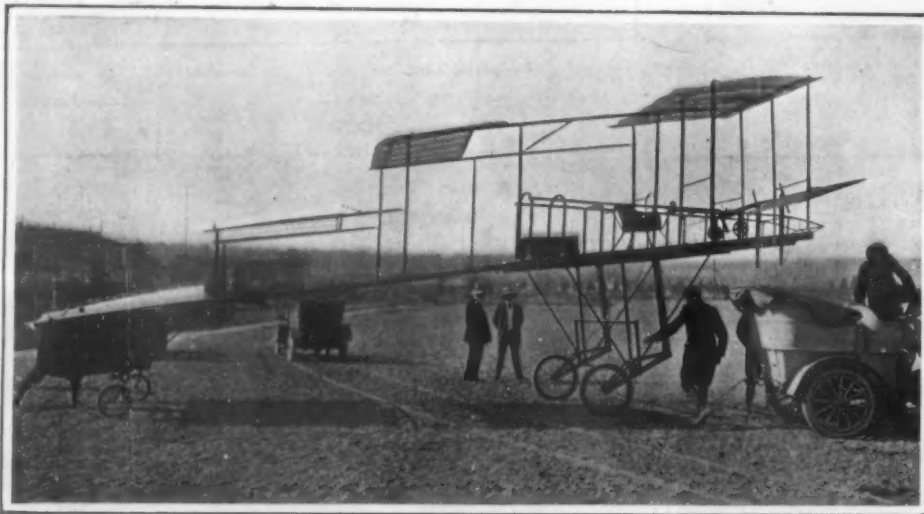
#### AN AEROPLANE FACTORY.

(Concluded from page 356.)

and to the curved ribs that pass through pockets in it, and thus hold it in the proper curve which it is desired that the surface shall have. The horizontal and vertical rudders are fitted in front of and behind these planes, the former being mounted at the forward end of the body framework, and the latter in the box tail at the rear. The main frame is supported upon a chassis of steel tubing by means of two long coiled springs that absorb the shock when the aeroplane alights upon its pneumatic-tired wheels. The two front wheels are pivoted so that they can assume any direction and act as casters when the machine alights.

In the construction of monoplanes the ribs of the wings are mounted upon steel tubes or I-beams of aluminium that are suitably secured to the body framework. The cloth is provided with eyelets and is laced in place.

One of our photographs shows a workman mounting the six planes of Farman's "Flying Fish" aeroplane upon the body framework. The planes can be set at varying angles, and the proper angle for them will be determined by experiment. The factory has a laboratory, in which experiments are made to determine the best form of aeroplane, the curves of the surfaces, and the resistance of the planes and of the framework. In constructing an aeroplane, use is made as much as



Side view of Witzig-Lioré-Dutilleul aeroplane, showing step-like arrangement of the following planes.  
SOME NEW AND IMPROVED FOREIGN AEROPLANES AND AIRSHIPS.

possible of the different light metals and their alloys. Ordinary steel tubing is used for the planes, while for the propeller shafts and the blades nickel steel, offering the greatest resistance for the least weight, is employed. All pieces working under compression are made of aluminium, in order to diminish the weight. The propellers, in particular, are very carefully constructed. The hub is made of cast steel, and to it are clamped the steel arms, which are forgings of very high resistance. To these arms are secured aluminium blades. When one notes that this mass of 2.3 meters (7½ feet) diameter revolves at from 1,000 to 1,400 revolutions a minute, one can see that it must be exceptionally strong. At 1,335 revolutions per minute the end of one of the blades travels through space at the rate of 525 feet a second (350 miles an hour) and the blade itself is constantly under a centrifugal force of nearly 9,000 pounds, tending to project it outward.

The motor is one of the most important parts of the aeroplane. Heretofore Voisin brothers have used only the Antoinette motors of the 8-cylinder V type; but lately they have adopted the "Vivinus," or the motor of the Belgian Société Metallurgique. This latter motor, which is the one used on the Goupy, Florio, Moore-Brabazon, Farman ("Flying Fish" for two passengers), and De Caters aeroplanes, is a 50-horse-power, lightweight, automobile motor weighing about 300 pounds. Whatever motor is adopted, the installation of it requires only a few days. In fact, a complete aeroplane can be constructed in about a week's time. The cost of one of these machines in France is \$4,000, half of which is represented by the motor. Very probably, however, the cost will be reduced as the machines come into more general use, for in reality, the materials used and the work necessitated in their construction are less than in the case of an automobile.

#### The Arc of Peru.

The committee of the French Academy of Sciences having scientific control of the French geodetic operations on the equator has reported the completion of the remeasurement of the historic arc of Peru.

This arc was measured by the French (1736-1743) and used in connection with a similar arc in the Arctic regions, also measured by the French, to decide a question in regard to the form of the earth which had arisen as the result of Cassini's surveys in France.

In 1889, the question of remeasuring this arc was brought before the International Geodetic Association by the delegate of the United States, Prof. George Davidson, who suggested that France should have the prior right to execute the work.

Circumstances prevented any active work until 1898, when the association voted in favor of the proposition to remeasure the arc, and the French delegates undertook to have the work done.

Officers of the Geographic Service of the French army left Paris for Ecuador in May, 1899, and the work was continued until completed.

The arc extends from Tulcan, Ecuador, Lat. +0 deg. 48 min. 25.6 sec., to Payta, Peru, Lat. -5 deg. 05 min. 08.6 sec., and the work accomplished in the remeasurement may be summarized as follows, viz.: Seventy-four geodetic stations. Three base lines measured.

Eight differences of longitude determined between stations at Tulcan, Piular, Quito, Latacunga, Riobamba, Cuenca, Machala, and Payta. The first five of these stations are distributed along the northern section of the arc, the sixth at the middle of the southern section, the seventh on the coast at the same latitude as the sixth, and the last at the end of the southern section, on the coast. The comparison of the differences of longitude, geodetic and astronomic,

between the stations at Machala and Payta and the station at Cuenca will throw light on the form of the geoid, as the first two stations are on the coast and the third is in the inter-andine region.

Six azimuths were determined, namely, at Tulcan, Piular, Quito, Riobamba, Cuenca, and Payta.

Sixty-four determinations of latitude were made.

The forty-eight magnetic stations were distributed all along the arc.

Of the six pendulum stations, one is at Machala, on the coast, at the point where observations for longitude were made; one at the foot of the western Cordillera, near Chimborazo; one, at an elevation of 4,150 meters in the western Cordillera; two, in the inter-andine region at Riobamba and

Quito; and one at an altitude of 1,800 meters in the plain of the Amazon on the eastern slope of the eastern Cordillera.

Of the two lines of levels of precision, one runs from the Riobamba base line to Guayaquil and to the tide gage at Salinas on the Pacific coast and the other from the southern base line to the tide gage at Payta, the two lines covering a distance of 410 kilometers.

The preliminary computations are far enough advanced to assure the value of the observations. The closure of the triangles and the agreement of the computed and the measured lengths of the base lines compare well with the results obtained in the revision of the meridian of France.

The publication of the results of the work will be regarded as an important event by geodesists throughout the world.—Abstract from Science.

A new and peculiar use for electricity has been found. The city of Zittau possesses extensive and beautiful forests, in which such depredations have been made by the larvae of the "nun" moth that it has been found necessary to cut down all the trees over large tracts. Last summer the electric light was enlisted in the warfare against the insects. On the roof of the city electrical station were mounted an exhaust blower and two powerful searchlights, the beams of which were directed to the forest five miles away. The hoped-for result followed. The moths flew by the thousand toward the searchlights but, before they could reach these, they came within the field of action of the blower and were carried away to destruction. In one night 66 pounds of moths were destroyed in this way, in addition to the great numbers of moths which found death in the electric arcs of the street lamps, from which the globes had been purposely removed.





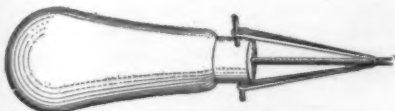
The Editor of Handy Man's Workshop will be glad to receive any hints for this department and pay for them if available.

Christmas Hints for the Handy Man will be published in next week's issue.

#### HANDY METHOD OF REPAIRING A PUNCTURED TIRE.

BY GEORGE F. LINKE.

The accompanying sketch shows a device for mending punctures in bicycle tires. It consists of a common darning needle of a large size and with a



A TOOL FOR REPAIRING PUNCTURES.

large eye, with its point inserted into a wooden handle. There are two pins also in the handle, projecting from opposite sides, and the top of the needle is cut off, leaving the end of the eye open.

To mend a puncture, stretch elastic rubber bands over the pins and through the slot in the end of the needle as tightly as possible until judgment shows that there is enough rubber to fill the puncture. Then insert needle and rubber through puncture in tire, throw the rubber off the pins and withdraw the needle. The rubber being tightly stretched will contract when released, filling the puncture and leaving a small lump inside and outside of tire. This will wear off outside in a very short time. It is advisable to ream the hole smooth before applying the rubber. This can be done by heating the needle with a match and then searing the edges of the hole.

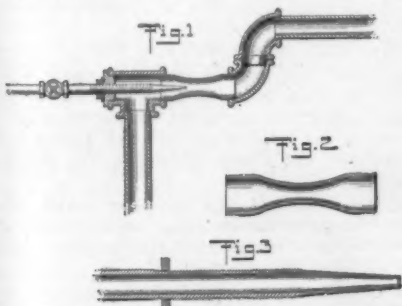
#### EJECTOR MADE OUT OF PIPE FITTINGS.

BY E. A. JOHNS.

A simple ejector may be made out of ordinary pipe fittings, which will compare very favorably with some of the ejectors on the market. It may be used in draining a flooded cellar, in which case it may be attached to the ordinary water faucet for motive agent. It can also be used for emptying cisterns or in excavations for new work where water is struck. (Of course, in this case, steam will be used as motive agent.)

Some time ago I was engaged in building a reservoir, and at a depth of 15 feet a spring of water was struck. Having no means at hand to get the water out of the excavation, I decided to make an ejector out of some old pipe fittings I had in the tool chest. I succeeded in making four that kept the water level down while the work was being done. One of these ejectors worked night and day for nearly three weeks until completely worn out, owing to the fact that a great amount of sand and gravel was carried through.

These ejectors can be duplicated as follows: First take a 1 1/4 x 6-inch nipple; screw on each end of same any kind of fitting so as to preserve the threads. Heat same in the middle to a white heat. Then swedge down until outside diameter is about 3/4 inch. When cold remove the fittings, and the cone is made (see Fig. 2). Now take a 1/2-inch pipe, heat one end to a welding heat, and swedge down to a long point. A



THIS EJECTOR CAN BE USED FOR DRAINING FLOODED CELLARS.

3/16 rod may be inserted in the end to give the hole the right dimension, as it may be drilled out afterward. When cold, thread the pipe about 4 inches and screw on a jam nut (see Fig. 3). On the "rim" of a 1 1/4-inch tee attach the cone above described and then a 1 1/4-inch elbow into which screw a close nipple. On the other end of the nipple screw another elbow, forming a kind of stop or stop. To this elbow may be attached either a hose or a pipe to carry off the water. On the opposite end of the tee attach a reducing bush-

ing, into which insert the nozzle shown in Fig. 3. Care should be taken to get the nozzle in perfect alignment with the cone, and when in proper place, screw up the jam nut with some packing behind it, to make it air tight. In the other opening of the tee attach a pipe or a very heavy hose, preferably "ironclad," as the suction will have a tendency to close it up.

#### STORAGE BATTERY WITHOUT CHEMICALS.

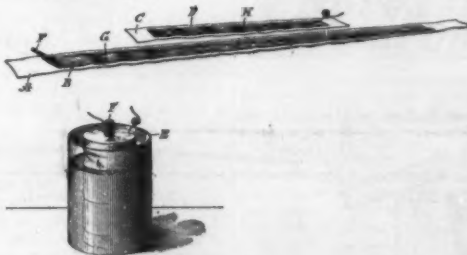
BY WALTON HARRISON.

An experimental storage battery, having qualities of interest, and at least remotely suggestive of commercial possibilities, may be constructed at a cost of a few cents, as follows:

Provide four strips A, B, C, D, of thin cloth (calico will answer), the strip A being 20 feet long and 4 inches wide, the strip B 18 feet long and 3 inches wide, the strip C 10 feet long and 4 inches wide, and the one designated as D 9 feet long and 3 inches wide. Procure an ordinary battery jar E of cylindrical form, a pound of commercial flake graphite, a few gum bands, and two pieces of No. 30 bare copper wire, one (G) being 20, and the other (H) 10 feet in length. These parts and materials, together with a carbon rod F of the kind used for arc lighting, comprise everything needed except water and enterprise.

Spread out the strips B and D, shower them liberally with water, and dust the graphite upon them. Then stroke them off with the hand. This will remove all excess of graphite, and leave them shining like strips of new tin plate. A single coating of the graphite upon one face of the cloth is sufficient.

Spread out the strip A, which remains uncoated, and lay the strip B centrally upon it, so as to leave exposed all margins of the strip A, its ends extending equally and in opposite directions beyond the ends of the strip B. Extend the wire G along the strip B from one of its corners to the opposite corner, the wire thus being slightly oblique relatively to the strip, and extending a couple of feet beyond one corner. Next place in position the strip C, which remains uncoated, centering it lengthwise in relation to the other strips, and bringing its longer edges flush with those of the



STORAGE BATTERY WITHOUT CHEMICALS.

strip A. Place the strip D on the strip C, leaving all margins equally matched. Stretch the wire H along the strip D, from one corner to the corner opposite, the wire being slightly oblique to the strip, so as to cross the wire G and leaving a foot of the wire H projecting.

Wind the projecting end (2 feet long) of the wire G tightly around the carbon rod F, and lay the rod squarely across the adjacent end of the strip B, so as to make good contact with the graphite. This will leave a foot of the strip A extending from the rod F. Bend this extending portion back over the rod so as to cover it, and then, using the rod F as a spool, roll it along, pressing it down hard; and thus wind tightly upon it all of the strips and both of the wires, so as to form a hard roll having generally the appearance of a solid white cylinder. Stretch two or three rubber bands around the roll, so as to hold all of its parts rigidly in position. Find the projecting end of the wire G, and leave it exposed. Set the roll into the jar, so that the exposed portion of the wire G and also a portion of the carbon rod F extend upwardly. Now fill the jar with water, preferably submerging the roll to within half an inch of its top.

This completes the battery. In some instances it may be improved by making the strips A C of cloth thicker than that above designated.

The battery may be charged from an ordinary dry cell, by connecting the zinc shell of the dry cell with the carbon rod of the storage battery, and the carbon of the dry cell with the protruding wire of the storage battery. After being thus charged for fifteen or twenty minutes, the storage battery may be disconnected, after which it will yield, for a few minutes at least, a current not differing greatly from that with which it was charged, and adequate to operate a telegraphic sounder or an electric bell. If the energy of the battery be conserved by leaving the circuit open, the charge may last for several days. Like other storage batteries, this one, after being partially exhausted, will recuperate to some extent if the circuit be left open, though of course the total energy it gives out can never exceed that with which it is charged.

This device is in every sense a true "gas" battery as well as a storage battery. While it is being charged,

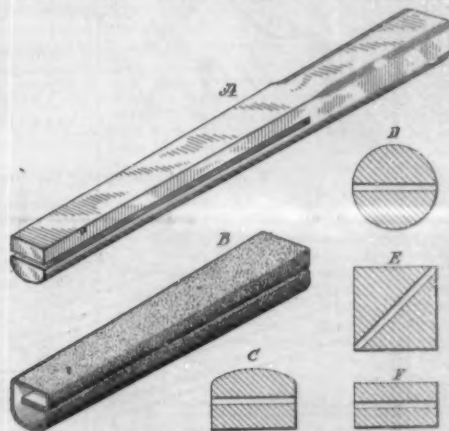
the current sent through it disintegrates a portion of the water into its two component gases. The hydrogen, being disengaged throughout the entire length and breadth of the graphite coating carried by the strip B, is simply absorbed or occluded within the pores of the cloth, and thus effectively held as a free gas in a state of captivity. The oxygen, being in part in its allotropic form of ozone, is similarly collected and held in the strip C. The strip A holding the hydrogen, being twice as long as the strip C holding the oxygen, is adapted to hold twice as much gas, thus compensating for the difference in volume between the hydrogen and oxygen. Both gases, being freshly liberated, are in their nascent state and eager to recombine. After the charging is completed, therefore, and a conducting path is established from one of the coated strips to the other, the gases recombine, forming water, and in so doing they generate an electric current flowing in a direction opposite to that of the current previously used for breaking up the water and forming the gases.

It is a fact not generally known that if a quantity of hydrogen and a quantity of oxygen be subjected as nearly as practicable to the same physical conditions, they will present relatively to each other a difference of potential of about a volt and a half.

#### CONVENIENT HOLDER FOR SANDPAPER.

BY EDWARD J. TIEDE.

In sandpapering irregular shaped woodwork, the paper is laid over a stick of wood and used practically as a file. For holding the paper I have often used a simple holder for different kinds of work with satisfactory results. The holder consists of a stick, preferably of pine wood, of the required shape and size and tapering slightly toward one end. Into the narrow end saw a slot in the center to about two-thirds its length. Cut off a piece of sandpaper wide enough to go around the stick, allowing a liberal margin to fit into the slot. Fold the paper so it can be slipped



CONVENIENT HOLDER FOR SANDPAPER.

into the slot and around the holder from the end; pull it down until it fits snugly, when it is ready for use. Emery cloth can be used in the same way for polishing parts of machines and the like.

In the drawing the holder is shown at A, and the paper folded ready to apply at B. The sections C to F suggest some shapes that may be used.

#### THE CONSTRUCTION OF A WORKSHOP.

BY L. C. BAYLEY.

The interest taken by the boy in a shop that is his very own, particularly if he is allowed to build it himself, will be very manifest, and the good derived, by keeping him off the street, if nothing else, will well repay the small outlay of the first cost.

Fig. 1 shows the inside view of a workshop good enough for any boy, no matter what his station in life may be. The framework was put up by a first-class mechanic, but the furnishings are all home-made, such as any boy will be able to construct. Such a shop as this is hardly necessary for the average young mechanic, the object of the sketch being more to show how a shop can be fitted up inside. The lathe, and also a jig saw, not shown, will be described, in a later number, as will also the bench, drawing table, and other accessories.

A shop about 9 feet by 12 inside dimensions will be ample enough, and if it is made as an addition to the house, but three extra sides will be necessary, or if built in a corner, as is sometimes convenient, then but two extra sides will be needed.

The ground must be leveled, and prepared for the six piers, which can be of concrete, brickwork, or timber. If of timber, let them be 6 to 9 inches square by 2 feet long, buried in the ground about 18 inches. Holes should be dug of suitable depth and the stumps dropped in, care being taken to get them the proper distance apart, 9 feet by 12, out to out, so that the sides of the building, when erected, will be flush, and not have to be cut around the piers, or offset in an



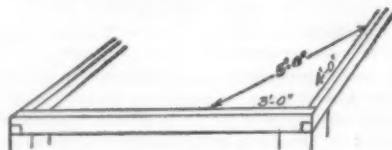
unworkmanlike manner. The first pier can be permanently set by ramming broken bricks and earth into the hole with a piece of heavy timber brought down on end. The remaining piers are leveled up from this one, by means of a builder's level.

Since it is a very important matter that these piers should be true and level with each other, it will be well to make a suitable straight-edge, or leveling board, for this purpose. This can be 12 or 16 feet in length, cut from a 1-inch board, and shaped as shown in the cut. A hand-hole is formed in the center, at the top, and a small shelf, upon which is placed the spirit level, is nailed to one side, immediately below. The leveling edge must be planed very true, while the small shelf on the side must be made exactly parallel with it. Place the level upon the shelf, and, holding the leveling board on the tops of each pair of piers successively, commencing with the permanent one, level them all by raising or lowering them in their respective holes, when they should be permanently set, as was the first.

The wall plates or bottom framing are made from 4x6 timber, half jointed at each corner, and secured to each pier with tenpenny nails driven in from either side. The four corner piers being 9x12 feet out to

and the door lintel. Rails and door lintel are 2x3 inches.

The rafters are made of 2x4-inch timber, notched where they rest upon the plates, which are 2 inches by 3. One rafter can be cut to the proper length and notched, using it for a templet, or as a guide for cutting the others. The two end rafters should be secured to the plates first, by driving in tenpenny nails through the sides, as in the case of the floor joists,



Laying out a square corner.

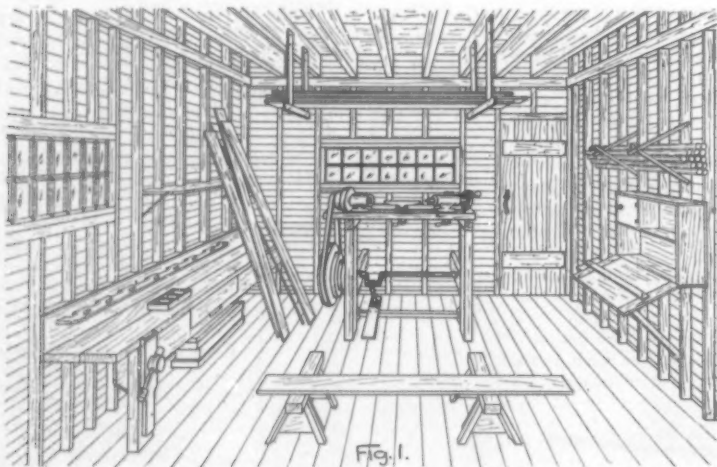
then the others may be evenly spaced from end to end, about 2 feet apart.

The framework of the building is now complete, as shown in Fig. 2. A detail of construction is shown to the right. Rough boards, with a space between them of about one inch, are laid across the joists for

on one side only, are cut to fit close up to the sides, and around the studding or posts, and nailed to the joists with eightpenny nails. The joists are 2x4, notched 1 inch, as shown.

It will be noticed that the first board of the sides, nearest the house, is notched all the way down, to fit up snugly against the weather boards. This is done by means of a pencil and a small stick, held as illustrated. The stick is traced along the outline of the weather boarding, while the pencil, being held against the upright board of the shop, makes an exact copy of the outline, as a guide for the saw. Narrow boards, sometimes called plates, are nailed all around the top of the sides, under the eaves of the roof, notching them out where the joists of the roof come through.

The door can be made of the same stuff as the sides, strengthened with battens as shown in Fig. 1. A diagonal batten can be put on also, letting it bear top and bottom against the horizontal battens, and taking care to let it slope in the right direction, the lower end being near the hinges. Hinges and a latch, also a draw-bolt, are all the furnishings necessary for the inside, and a padlock for the outside. A plain narrow frame can be put around the outside of the win-



A model workshop for the amateur.

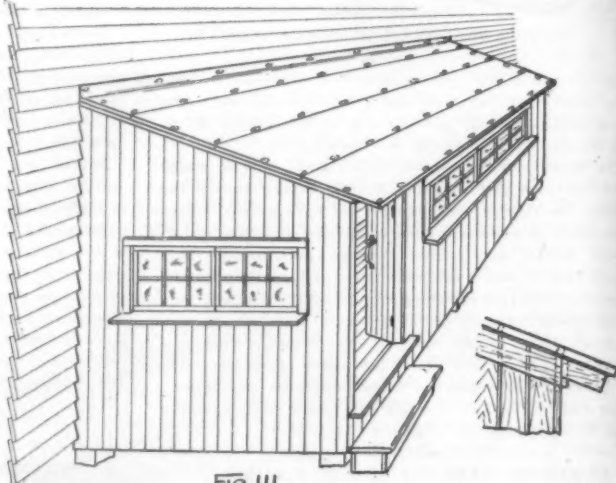


Fig. III

Exterior view of the finished building.

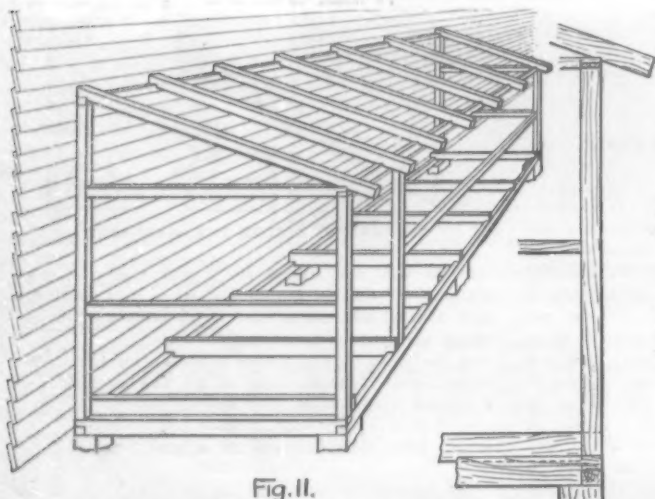


Fig. II.

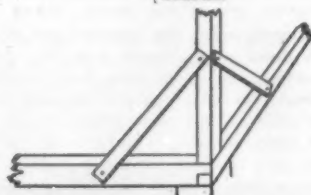
Setting up the frame of the shop.



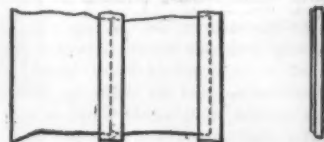
A builder's level.



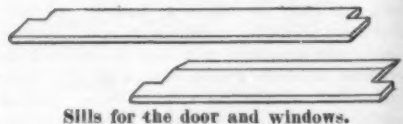
Tracing a profile of the weather boards.



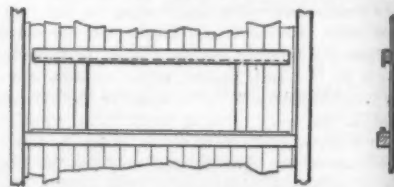
Temporary bracing for corner posts.



Cracks in the siding covered by narrow strips.



Sills for the door and windows.



A window opening, showing grooves for sash.

#### THE CONSTRUCTION OF A WORKSHOP.

out, one pair of the 4x6 timbers will be 12 feet in length, and the other 9 feet. The framework must form a perfect right angle at each pier, which can be tested by means of the carpenter's square or laid out in the following manner:

Along the inside edge of the framework lay off a line 3 feet in length on one timber and 4 feet on the other, when the two timbers must be closed, or opened, until the distance between these two points measures exactly 5 feet, as shown in the sketch.

The posts, or studding as they are sometimes called, are made from 3x4-inch timbers. Two are cut 10 feet 6 inches in length, and three are made 7 feet 6 inches long. The ends are cut true and square, to get a good bearing, when the posts are set up. The rear posts can be secured to the side of the house, after being tried with a plumb bob, or level, and can be secured to the bottom plate or framing by toenailing; but the two front corner posts, after being erected plumb, and secured to the framing, must be held temporarily, in the manner illustrated. The top plates and rails are next put up. Make a half joint at the front, and nail the other ends to the rear posts with nails driven through either side. The other door-post is erected, then the intermediate rails

the roof, and secured with eightpenny nails. The sides can either be made of tongue-and-grooved boards, or ordinary boards like the roof, only built close, with narrow strips of wood nailed over the joints.

Space must be left in the sides for the windows and doorway; the latter should measure 2 feet 6 inches by 6 feet 6 inches. The windows had better be double sliding, on three sides of the building, to get a good light. If 10x8 glass is used, the framework or sash will be about 2 feet 4 1/4 inches by 1 foot 11 1/4 inches high. The window openings in the sides of the building, therefore, should be 1 foot 11 inches high by 4 feet 8 inches long for a double sash. They should be centrally located in the sides and front, the boards being cut flush with the top of the middle rails, to which they are nailed. The boards at the top of the opening are nailed to an inside strip, 2 1/2 by 1 1/4 inches, detailed in one of the sketches, which sketch also shows the grooves in which the sash moves. A tongue-and-groove connection should be made where the two sashes meet, or a strip of wood should be nailed on either, to overlap the other, and keep out the wind and rain.

The flooring, which can be made of ordinary boards or a cheaper grade of tongue-and-groove boards, planed

dows, and a sill made from 1-inch stuff, for the door and windows, will improve the appearance. A doorstep can be made from the same stuff as the sides, or from 1-inch boards, nailed to the front of the shop, before the tread is put on. The ground should be made level, and a large stone, or bricks, put under the bearing edge.

The roof is covered with tar paper, which can be made of sheets of brown paper, covered with pitch and sanded, or it can be purchased already prepared. Commence at the eaves, allowing enough to tuck under the eaves on both sides and in front. The next layers are allowed to lap over by about 2 inches, and the last one is tucked under the weather boarding, on the side of the house. Large-headed galvanized nails are used to hold the tar paper or felt covering to the roof; or barbed wire nails with tin caps will do. Space them not less than 2 or 3 inches apart, all along the edges of the laps, and under the eaves of the roof.

The shop should be given two coats of paint on the outside to match the house or surrounding buildings. A small stove, either oil, gas, or coal, will nicely heat the shop in cold weather, a chimney connection being made in the roof or one of the sides if a coal stove is used.



## RECENTLY PATENTED INVENTIONS.

## Pertaining to Apparel.

**SHOULDER-BRACE.**—M. W. FERRIS, South Orange, N. J. The braces tend to hold the body of the wearer in proper upright position, with a view to insure an upright, healthy carriage at the same time allowing sufficient yielding for comfort, protecting the arm straps against perspiration, preventing the shoulder straps from accidentally sliding off the shoulders, and allowing convenient adjustment to accurately fit the body.

**POCKET FOR SHIRTS.**—S. ELBAUM, Bayonne, N. J. The invention relates to outer shirts for working men, mechanics and other persons, and its object is to provide a pocket for shirts, which is provided with separate compartments, one for general storage purposes, one for the safe housing of a watch, and one for containing a lead pencil, rule or the like.

## Electrical Devices.

**AUTOMATIC FIRE-ALARM SYSTEM.**—C. J. FOX, 11 Queen Street Place, London, England. The invention consists of a combined electric bell service and automatic fire alarm system; that is to say, a system in which the leads for the electric bell installation serve also as leads for the fire alarm thermostat circuit, so that the leads appertaining to the thermostat in any apartment will be tested each time the electric bell in said apartment is used.

## Of Interest to Farmers.

**CHURN.**—A. BARBER, Watonsville, Cal. More particularly the invention relates to churns such as are provided with improved dashers whereby a more effective action is brought about in churning. The device is provided with a dasher having three vertical blades, the intermediate blade serving pivotally to mount the dasher in position and to facilitate its rotation.

**COTTON COMPRESS.**—T. B. LEE, Charlotte, N. C. This improvement provides a dense and uniform bale and completes it before releasing any pressure. It provides means for neatly and conveniently covering the bale with bagging and securely hooping the same with the wires or bands. It also provides a bale which can be sampled at any part of the same, so as to show the character of the cotton in the entire bale, leaving no chance for false packing.

**BALE-TIE.**—D. MARGOLIUS, Norfolk, Va. The improvement is more especially in such ties as are employed on cotton bales, the improved feature residing primarily in the connection between the ends of the tie. The fastening between the overlapping ends of the tie is made so that the tie will not catch in the press. It is applicable not only to joining the ends of new ties, but also in joining one or more pieces of an old tie together.

**COTTON CHOPPER AND CULTIVATOR.**—R. H. PURNELL, Rosedale, Miss. A special feature of this machine lies in the means for preventing stubble, weeds, or trash of any kind from being drawn inward by the hoe in its revolutions, whereby the latter would become clogged and its work rendered imperfect. Another is the rotary bevel disks that when set in one position serve to throw dirt toward the row of cotton plants, whereas when arranged at an opposite inclination they serve to scrape the sides of the cotton row. It is an improvement upon the machine for which Mr. Purnell formerly obtained Letters Patent.

## Of General Interest.

**METHOD OF TREATING HIDES.**—W. J. WARD, West Philadelphia, Pa. This invention refers to the treatment of hides or leather, preliminary to the tanning process, for the purpose of removing hair and grease, and of ultimately improving the quality of the leather to be made. The method makes plumper leather and it does not "pipe with the grain."

**SAFETY ROPE-GRIP.**—C. F. SINCLAIR, Jersey City, N. J. The object in this instance is to provide a rope or grip for attachment to the wrist of a person and for connection with one of the guide ropes of the bathing place, to allow the user to safely venture into the water for bathing and swimming purposes, and to aid the user in learning to swim.

**PROCESS OF MAKING CANDY.**—L. HIRSCHFELD, New York, N. Y. This process is designed to impart to pulled candy a peculiar consistency, rendering the candy less strenuously tough than ordinarily and permitting the candy after a time to completely dissolve in the mouth, and a further purpose is by means of the process to obtain a product that will retain its consistency for a great length of time.

**LOGGING-JACK.**—C. D. MOORE, South Bend, Wash. In this patent the improvement is in that class or type of jacks in which a rack-bar is raised by means of a pivoted lever provided with a pawl adapted to engage a rotatable ratchet which is in turn connected with the rack-bar through the medium of a pinion.

**DISPLAY-RECEPTACLE.**—M. GIANINI, New York, N. Y. Candy boxes are often arranged with trays or divisions for different kinds of candy, but they are not all in view. A box constructed according to the present invention is especially useful for this purpose, as the

box may be opened out to expose the contents of all its divisions. While intended especially to be used as a candy box, it may be used for other purposes.

**FASTENING DEVICE.**—A. C. GODDARD, New York, N. Y. The invention relates to metallic door casings, base boards, chair rails and the like, and its object is to provide a device for fastening the metallic parts in position without the use of screws, nails and the like and without showing the fastening means exteriorly.

**EASEL.**—GENEVIEVE BOOTH, New York, N. Y. The invention relates to improvements in devices for use in supporting pictures, pamphlets, books, and the like, and relates more particularly to that type of holder formed of sheet metal and serving not only to support the picture, pamphlet, book, or copy, in a substantially upright position, but also serving to hold it in an open position.

**HORSESHOE.**—P. W. CARNEY, Norfolk, Va. In this patent the invention is an improvement in horseshoes having for an object the provision of an attachable and detachable attachment having calks, and which can be readily applied to ordinary horseshoes when necessary and removed therefrom when the necessity for calks no longer exists.

**VAGINAL SYRINGE.**—O. KATZENBERGER, San Antonio, Texas. The purpose of this invention is to provide details of construction for a syringe, which adapt it for a very convenient service, and enable the internal application of a suitable medicinal liquid or powder for the disinfection or cure of diseased tissue, the said liquid or powder being preferably employed as a remedial agent.

**HOOF-PAD.**—D. T. BARBER, Gustavus, Ohio. In the present patent the invention is an improvement in that class of hoof-pads which are formed of elastic material and are arranged beneath a metal shoe and are secured to the animal's hoof by the same nails that hold the shoe.

**CAN-OPENER.**—C. E. SANDS, Palatka, Fla. In operation the pointed end of the long arm is inserted in the can top, at approximately the center thereof, and bent downwardly until the cutting wheel is in contact with the tin. The arm is now revolved around the edge of the top, the cutting wheel being held firmly in contact therewith, thus severing the center of the top from the margin.

**ANIMAL-TRAP.**—L. HORINKO, New York, N. Y. The purpose here is to provide a device for catching small animals, such as mice, rats, etc., which embodies in its construction a cage, an auxiliary cage open at both ends and having means adapted to hold the bait, and a trap door in the top of the cage, forming the bottom of the auxiliary cage.

## Heating and Lighting.

**CLEANING DEVICE FOR FEED-WATER HEATERS.**—T. V. ELLIOTT, New York, N. Y. In this case the object of the invention is to provide a new and improved cleaning device, more especially designed for effectively cleaning feed water heaters whenever desired, without requiring shutting off the feed water from the boiler.

## Household Utilities.

**WASTE FOR BATH-TUBS, BASINS, AND LIKE FIXTURES.**—P. F. GUTHRIE and T. HAYES, Nutley, N. J. The object of the invention is to provide a waste for bath tubs, basins, and like fixtures, arranged to prevent contaminated water rising into the fixture when filling the same with water. It relates to wastes such as shown and described in the Letters Patent of the U. S., formerly granted to Messrs. Guthrie and Hayes.

## Machines and Mechanical Devices.

**BOAT-HANDLING DEVICE.**—L. TANNING and W. J. RYAN, New York, N. Y. The invention pertains to boat-handling devices, the more particular object being to enable a boat carried on shipboard, to be readily raised from the chocks, normally supporting it, and otherwise made ready for immediate action upon the water.

**APPARATUS FOR COALING SHIPS AT SEA.**—A. JOHAN, New York, N. Y. Transferring is done by placing a collier in tow of the vessel and providing one or more traveling cables between them, on which the coal or other material is carried, said cables having means to maintain them under constant and equal tension during rolling and pitching, the tension on the cables being maintained irrespective of the tension on or slackness of, the hawser connecting the two boats together.

**STOKER.**—T. V. ELLIOTT, New York, N. Y. The object of the present invention is to provide a new and improved stoker for use in automatically feeding coal and like fuel to a furnace, to automatically remove the ashes, to insure at all times a proper uniform combustion of the fuel.

**ATTACHMENT FOR KEY-OPERATED MACHINES.**—J. V. Y. DIAZ, Habana, Cuba. The invention relates to improvements in typewriters or other machines having a plurality of keys adapted to be manually operated, and the object of the invention is to provide means for locating and defining the keyboard by other than the sense of direct sight, whereby the operator instinctively retains the hands in the proper position in respect to the keyboard

while reading copy and operating the machine simultaneously.

## Railways and Their Accessories.

**MOLD.**—J. WILSON, Rochester, N. Y. This improvement is for use more especially for chilled car wheels, and has in view primarily a molding flask by which the variation at present experienced in the thickness of flanges and the weight of the wheels, will be eliminated, and a uniform and well balanced wheel produced.

**MAIL-HANDLING APPARATUS.**—M. M. MILLER and G. S. STEINBERGER, Allentown, Pa. The invention relates more particularly to apparatus which is used with mail or other railroad cars for securing and delivering mail bags, and is adapted to be arranged adjacent to a railroad track, and which has means for receiving mail bags from a train while the latter is in motion.

## Pertaining to Recreation.

**AQUATIC MERRY-GO-ROUND.**—H. H. RIEHL, New York, N. Y. The invention refers to amusement apparatus, such as are used in parks, exhibition grounds, pleasure resorts, and the like. The object of the inventor is to provide a new and improved aquatic merry-go-round, arranged to provide an exceedingly novel and highly interesting ride.

## Pertaining to Vehicles.

**SWINGLETREE AND DOUBLETREE.**—G. P. SIMPSON, Marysville, Idaho. The invention is applicable to swingletrees, doubletrees, neck-yokes and similar constructions. The construction is simple, easily applied, reinforces and strengthens the body and protects the rear side of said body when the latter is used as a swingletree against injury from coming in contact with the wheels or other portions of the running gear of the vehicle.

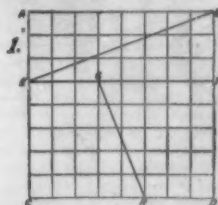
**NOTE.**—Copies of any of these patents will be furnished by Munn & Co. for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.



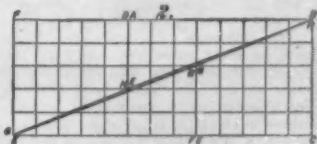
Full hints to correspondents were printed at the head of this column in the issue of November 14 or will be sent by mail on request.

(10994) G. L. P. writes: H. J. F. asks if a piece of paper 8 by 8 inches square can be cut so as to make 65 square inches. You say: "No, by no conceivable means." Now you will find enclosed a piece of paper 8 by 8 inches, which you are to cut on the lines and put together as lines shown on the smaller piece, and then measure. I think you will find it to be 5 by 13 inches, which equals 65 square inches. I am unable to explain where the square inch comes from, but it is there. A. No, friend, it is not there. We exceedingly regret that any of our correspondents should think us capable of believing that a square of eight inches on a side can be cut into pieces and put together in another way so that its area shall be increased 1 square inch. We are having a deluge of letters on this point, of which we print one, many criticizing us more or less severely for saying that this cannot be done. But of course it cannot be done. We repeat it—No, by no conceivable means. It transcends common sense to ask it. Try it with pennies, or kernels of corn, or any convenient similar pieces. Lay out 64 in a square of eight on a side. Then change them to a figure of 5 rows of 13 on a side. There will be a missing kernel or coin. You cannot complete the second figure. It is the same if you cut a piece of paper of the same dimensions; 8x8 cannot be anything but 64, and can never be 65. Why not settle one's self first upon simple foundations? Then one will not say, as our confident correspondent does, "But it is there." That begs the question. It is not there, and cannot be there. There is evidently a fallacy here somewhere. Now, this is no new trick. It has been traveling around for an unknown period of time, and has been shown up as often as it appears. THE SCIENTIFIC AMERICAN had it a generation ago. Still, apparently, there are a host of intelligent people who have never seen the exposure. Hence we will give it, not following the usual mode of treatment, but giving our own explanation of the fallacy of the proposition. This is not a puzzle, for a puzzle should have a rational solution, and this thing has no such solution. It is a trick, to make the false seem true. The proper attitude of mind toward it is to seek for the reason of its fallacy, since it cannot be true. Only one of our correspondents even suggests that it cannot be true. When you see a juggler perform an impossible thing, such as cutting a man's head off, pulling a great quantity of dry goods out of a hat, or doing the curious box trick, you do not immediately demand that all these shall be accepted as realities; on the contrary you seek the method of the deception. That is the right attitude of mind toward a physical impossibility, and is applicable here. Perhaps the

easiest way to show the falsity of the question under discussion, is to draw a figure 5x13, divide it into squares and draw a diagonal line across the figure as in Fig. 3.



Our Fig. 1 shows the square of 8 inches divided for the purpose of the puzzle. Draw the perpendiculars as shown and the points HE and BG do not fall at the corners of squares. They cannot. Yet the so-called solution which all our correspondents send us, shows the same thing—that the lines EG, HF, AE, BF, which should be 3 inches long, are more than 3 inches long. In every figure



this is so. You should be sharper than to draw a figure like that and send it to us if you are to convict us of error. There is an error, but you are in error. The diagonal of your long figure, 5x13, must be a straight line, if you are correct, but the four pieces of paper when put together do not give a long straight diagonal, as any one can see who will put the pieces together, then use his eyes and look for himself. If your eyes will not show it to you, take a straight ruler and it will disclose the truth for you. The long, sloping line of the pieces of paper is not straight. The four pieces of paper do not cover the area which they seem to cover. There is a long, narrow strip in the center which is not covered. The area of this strip is just one square inch, the square inch you think you gain. You put your rulers on and draw a long straight line sweeping from one corner of the 5x13 figure quite across to the other corner, and say "There it is, I have made 64 square inches into 65 square inches." Great act! But you have not. Now turn to the square of 8 inches on a side, our Fig. 1. The line HE slopes 3 inches in 8, or  $\frac{3}{8}$  of an inch in 1 inch. The line BG slopes 2 inches in 5 inches, or  $\frac{2}{5}$  of an inch in 1 inch. And you ask us to believe that a line whose slope is  $\frac{3}{8}$  should form a straight line with one whose slope is  $\frac{2}{5}$ . We cannot do it. The reason anyone is deceived is that the pieces are rarely cut with a high degree of accuracy. They are often cut out of thin paper, and will not lie flat. When they are put together they seem to cover the space as well as could be expected and so the deception takes effect. If the trick were approached from the other side, that is, cut the pieces from the piece which is 5x13, and put upon a square carefully drawn to be 8x8, the pieces would then more than cover the square figure and deception would not be so easy.

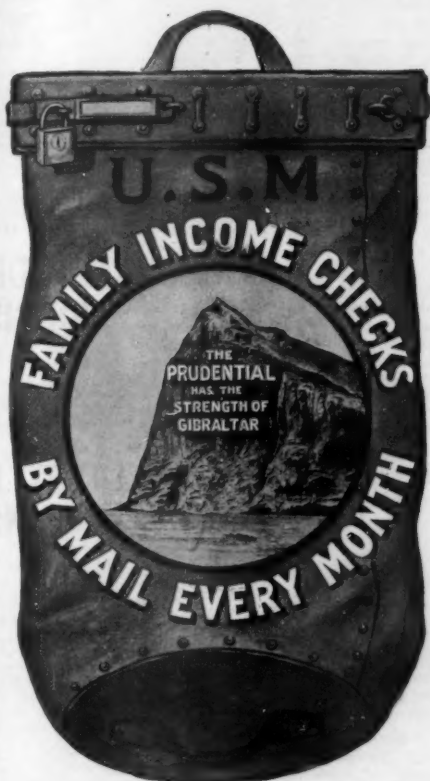
(10995) G. R. M. asks: Will you kindly answer the following through the columns of Notes and Queries in your valuable paper, and oblige a faithful reader: 1. What causes the changes of the moon? A. The phases of the moon are produced by the moon's revolution around the earth. The sun shines upon the moon all the time. When the moon in its motion around the earth comes between the sun and the earth, the sun is shining upon the side of the moon which is farthest from the earth. The dark half of the moon is toward the earth. That is the time of new moon. About two weeks later the moon has traveled around so that it is farther from the sun than the earth is, and the earth is between the moon and the sun. The lighted side of the moon is toward the earth. That is full moon. As the moon has changed from showing no lighted surface to the earth to showing the entire lighted surface to the earth, there was a time when she showed half her lighted surface to the earth. That was first quarter. Similarly there will be a time between full and new moon, when she will show half her lighted surface to the earth. That is last, or third quarter. If you will look up this matter in astronomies in your city library, you can read about it, and see the illustrations of it in the books, which will give you a much better idea than mere description in words. Ask the librarian about it. 2. Why does the mercury in the barometer stay higher when storms come from an easterly direction than it does when they come from any other direction? I have noticed this time and again and some of our largest and worst storms come from the east, and still the mercury will stay away up. I have wondered if the ocean had anything to do with it. As regards the power of a telescope, what is meant when manufacturers say they magnify 20, 33, or 60 diameters? A. We were not aware that a storm coming with an easterly wind was characterized by a higher barometer than one which comes with the wind from a southerly quarter. Storms ~~never~~ travel from west to east around the world, in crossing our country the paths







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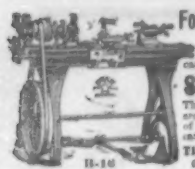
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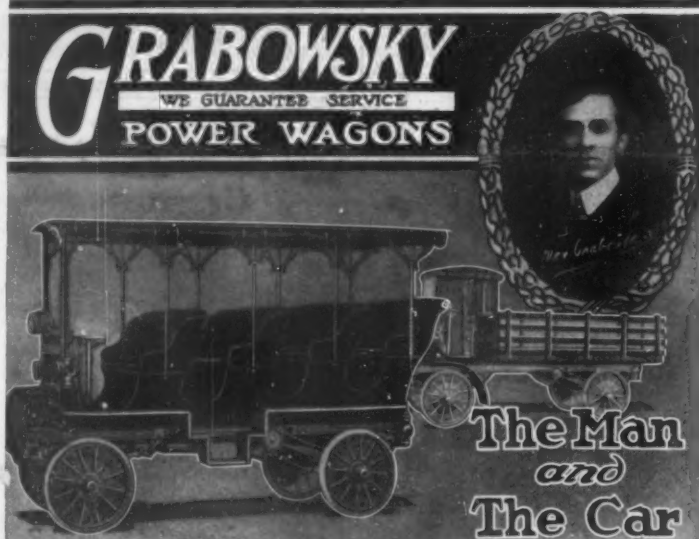
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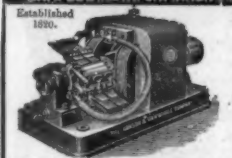


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